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The Wireless World AND RADIO REVIEW

VOLUME XXV

JULY 3rd—DECEMBER 25th, 1929

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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AMATEUR STATUS.

IN the leading article in our issue of June 19th we drew attention to the contrast in the treatment meted out to the amateur transmitter in Britain and in the United States of America. Here every effort appears to be made by the Post Office authorities to crush amateur activities and limit the number of amateur transmitters to a mere handful by imposing cumbersome and, we think, unnecessary restrictions, which even the Post Office officials themselves seem unable to interpret.

Something should be done, if only in the interest of the country generally, to revive the transmitting amateur and give him a reasonable place in the ether, a place at least comparable with the status enjoyed by American amateurs across the Atlantic.

U.S. Signal Corps Co-operation.

We pointed out in our leader that the Signal Corps in America co-operates closely with the transmitting radio amateurs and, amongst other things, undertakes to render "such encouragement and assistance as may be desirable to firmly establish and perpetuate the American amateur."

We do not want to lay the blame for the present position on the amateur himself, but we must confess that our feeling is that the amateur has permitted himself to be crushed without even showing the resentment of the proverbial worm. After the War, and for a number of years, the Radio Society of Great Britain was a very dominant factor in the affairs of the British amateur, and it was through the activity of that body that facilities for experimental work were wrested from the Post Office (for nothing was given away in those days, and every concession was fought for inch by inch). But to-day the Radio Society has, as far as the evidence goes to show, allowed the Post Office to deprive the amateur of a great deal which had been so hardly fought for and eventually won in the days gone by.

Is the Amateur Himself to Blame?

We do not wish in any way to criticise the work of individuals at present responsible for directing the destinies of the Radio Society, but we feel our suggestions will not be misunderstood if we say that looking into the present conduct of the Society as compared with past days, we think the trouble lies in the fact that the present executive is composed of individuals who are such enthusiastic transmitters and experimenters themselves that they have not the time, nor perhaps even the inclination, to be concerned with affairs of administration and the politics of wireless, and yet their very existence must depend on the way in which their Society and others connected with amateur activities handle the politics of the situation. Although the Radio Society may no doubt have gained in popularity amongst transmitting amateurs, we feel that it has lost something of its old reputation as a body prepared to fight to the bitter end, if necessary, for the rights of the amateur. Letters from readers indicate quite clearly that the necessary enthusiasm still exists which would ensure a success being made of the amateur transmitting movement, if it were not for the unreasonable attitude which has been taken up by the Post Office, an attitude which has so disheartened our best amateurs that many have given up their transmitting licences. The urgent need of the moment is for the transmitting amateurs to prepare a strong case to justify their existence, and proceed by every means to re-establish themselves with the authorities, and particularly gain the support of those branches of the services which are in a position not only to justify the amateur, but to make of the transmitting amateurs collectively a first-class national asset.

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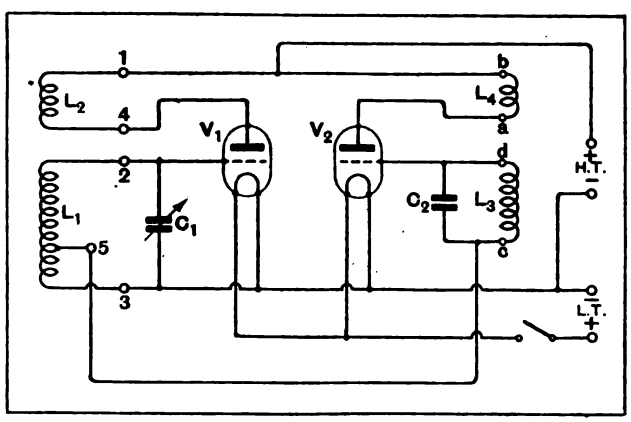
Modulated Wavemeter

An Aid to Accurate Tuning and Distant Reception.

By H. B. DENT.

IN spite of what has so often been said to the contrary, there is, at the present time, much pleasure and enjoyment to be found in listening to distant transmissions; indeed, modern receivers, whether they have one or more H.F. stages, are quite capable of picking up and reproducing at comfortable loud speaker strength items broadcast from a source some thousand miles or so from the receiver. Such sets are naturally rather difficult to adjust to any desired wavelength, since a powerful signal on a near-by wavelength will act as a magnet to the operator, and weaker signals, possibly of greater interest if capable of accurate tuning in, will be overlooked or more likely swamped owing to the difficulty of isolating them from the giants of the ether.

Familiarity with the receiver will eventually overcome this difficulty, but it takes time; moreover, many experimenters' sets rarely live long enough for the owner to become really familiar with them. A good set capable of great things is more often than not modified owing to the tedium of adjustment, even though with all circuits correctly tuned surprising results can be obtained. A set which shows promise should not be relegated to the background before it has been given an opportunity to justify its existence, and if adjustment is critical, why not help things out by means of a wavemeter? The instrument which is to be described here should prove an invaluable accessory to all those indulging in long-distance reception, and while, perhaps, a little more ambitious than those generally used, will be found far more satisfactory, since it possesses a degree of selectivity extremely difficult to achieve—if at all possible—with the popular buzzer type. Briefly, the arrangement consists of a heterodyne wavemeter with a low-frequency signal superimposed on the H.F. oscillations.



Theoretical circuit. $C_1 = 0.0005$ mfd. $C_2 = 0.01$ mfd. V_1 and V_2 are general purpose valves.

It possesses, therefore, the selectivity of the heterodyne type coupled with the advantages of the buzzer arrangement, since an audible signal can be heard in the loud speaker without causing the set to oscillate. Quite apart from the fact that a reradiating aerial is not in keeping with the courtesies of the ether, few modern sets fitted with real H.F. stages incorporate a reaction circuit.

Modulation by Additional Valve.

From the theoretical arrangement of the wavemeter, which is given in the circuit diagram, it will be seen that two valves are used. V_1 is an H.F. oscillator and V_2 a low-frequency modulator. A few may look askance at this, and regard it as somewhat extravagant, so perhaps it would be as well at the outset to state that any general-purpose type of valve, provided it is in reasonably good condition, can be used. The advent of the screen-grid valves must have displaced one or more three-electrode valves of the H.F. type, and since these are now probably decorating a shelf, here is a useful job for them to do before they come to an untimely end by being swept off during the bi-annual clean-up of the workshop

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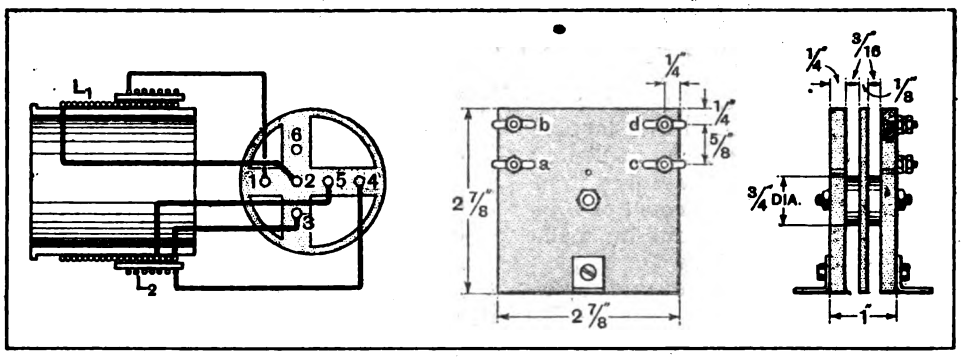
Modulated Wavemeter.—

The question of H.T. and L.T. need not be regarded as a serious drawback, because the spare accumulator can be pressed into service on the occasions the wavemeter will be required, and as for H.T., a 36-volt, small-size battery will suffice for the best part of a year. Most of the components can be salved from the spare parts box, but it would be advisable to use a really good logarithmic type variable condenser. This is the only item that need be purchased, provided that the other suitable parts can be found in the workshop. By fitting the same type condenser as used in the model illustrated much time will be saved in calibrating the instrument, since the curve given here can be redrawn on graph paper by shifting the condenser graduations right or left, as the case may be, after taking one or two check readings on some of the B.B.C. or Continental stations whose wavelength can be relied on.



Details of the two coils. L_3 and L_4 are wound on the two-slot former and each has 5,000 turns of No. 40 S.W.G. enamelled wire.

Air-core Audio Oscillator.

Now a word or two with regard to the modulator circuit. Originally a discarded L.F. transformer was tried, but subsequent tests proved this to be unsatisfactory, and finally recourse was made to air-cored coils. A modulating frequency of about 900 cycles was chosen, and this was found rather difficult to achieve with a transformer, although various types were tried.

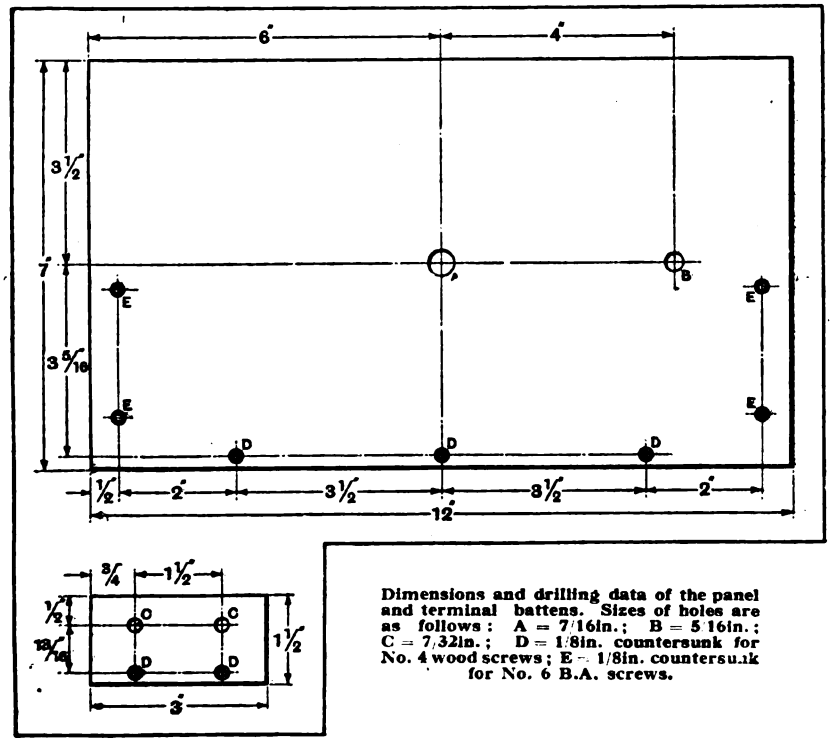
Possibly some readers may be more fortunate than the writer, so that, should it be decided to try out the idea, it is suggested that the arrangement which is most likely to be workable is that in which the primary is used as the tuned grid coil and the secondary as the reaction coil.

Modulation Method.

With a fixed condenser of 0.01 mfd., the grid coil will require an inductance of about 3 henrys to produce an audible note of the order of 900 cycles. The majority of old transformer primaries show a much higher inductance than this, especially as there is no D.C. through the coil which, by virtue of its effect on the permeability of the iron circuit, generally causes the primary to lose some of its henrys. However, the construction of the slab type inductances will be found reasonably simple, and probably lead to a considerable saving of time in the end.

The only other matter of interest that requires comment is the method of mixing the low- and the high-frequency oscillations. It was this, more than any other consideration, that led to the choice of two valves. A single valve oscillating at both frequencies could be made to work at times, but the arrangement was somewhat uncertain in its operation. The most serious snag of all, however, was met with in the mixing department, and although various arrangements were tried, no simple means of controlling the amount of L.F. modulation could be devised. A superabundance of L.F. leads to poor selectivity. The envelope of the H.F. oscillations must be very lightly modulated, otherwise the wavemeter becomes no better than one of the buzzer type.

The method chosen here offers one solution to the problem, although others may suggest themselves to the reader,



Dimensions and drilling data of the panel and terminal battens. Sizes of holes are as follows: A = 7/16in.; B = 5/16in.; C = 7/32in.; D = 1/8in. countersunk for No. 4 wood screws; E = 1/8in. countersunk for No. 6 B.A. screws.

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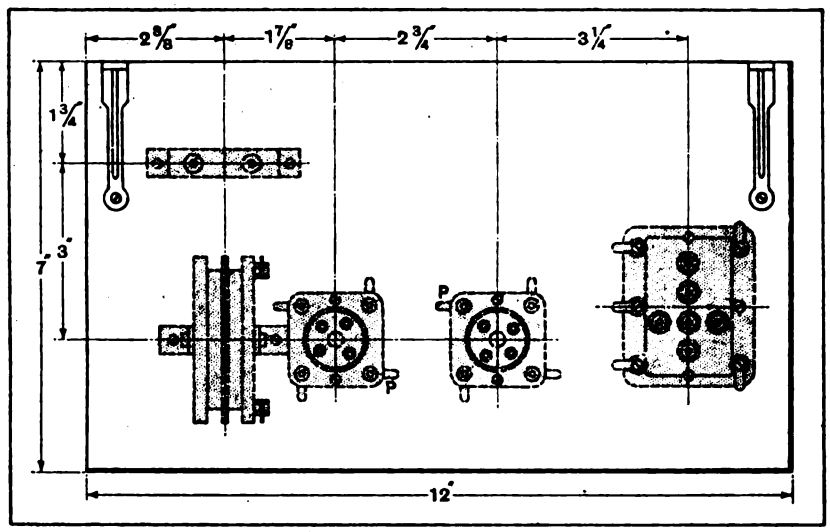
A plug-in H.F. oscillator, consisting of coils L_1 and L_2, wound on a Colvern six-pin former, is employed, since it renders the wavemeter flexible, and to extend its usefulness either to higher or lower bands suitable coils can be wound and plugged in when required.

The construction is, relatively speaking, simple, and does not call for detailed description. Accordingly, this will be dealt with in the briefest manner possible. The panel and baseboard presenting no difficulties, attention will be directed to the two coils. The modulator coils, L_3 and L_4, will be taken first. As will be seen from the illustrations and drawings, both grid and plate coils are wound on a two-slot former built up from pieces of ebonite held together by a screw passing through clearance holes in the centre of each piece. Square cheeks have been used because this is the simplest form of construction and does not call for access to a lathe, as would be the case if a bobbin turned from a solid block of ebonite were employed.



Baseboard layout. The modulator coils are shown on the left.

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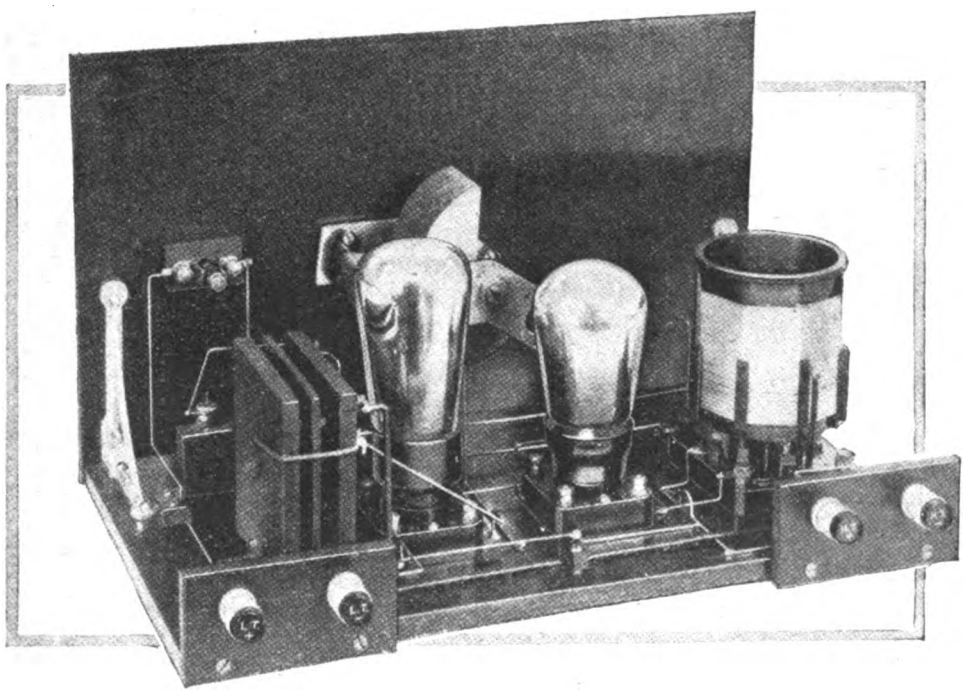
The H.F. oscillator coils are wound on a ribbed former, the grid coil being put on first and the reaction winding supported on ⅛in. spacers over the low potential end. For the grid coil 70 turns of No. 26 S.W.G. D.C.C. will be required; this is close wound; while the reaction coil contains 12 turns of No. 34 S.W.G. D.C.C. wire spaced 16 turns to the inch. When winding L_1, a tapping should be made at the 10th turn from



Rear view of the wavemeter The right-hand valve is the H.F. oscillator and the modulator is on the left.

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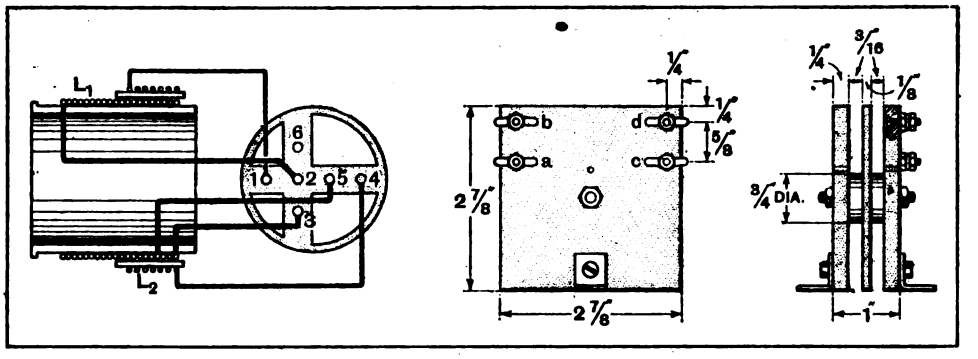

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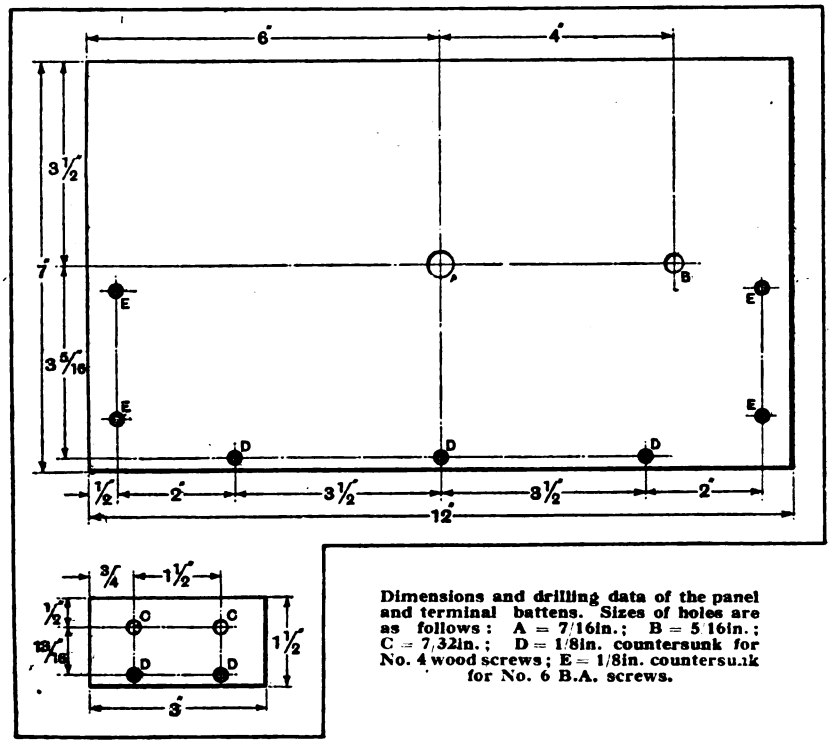

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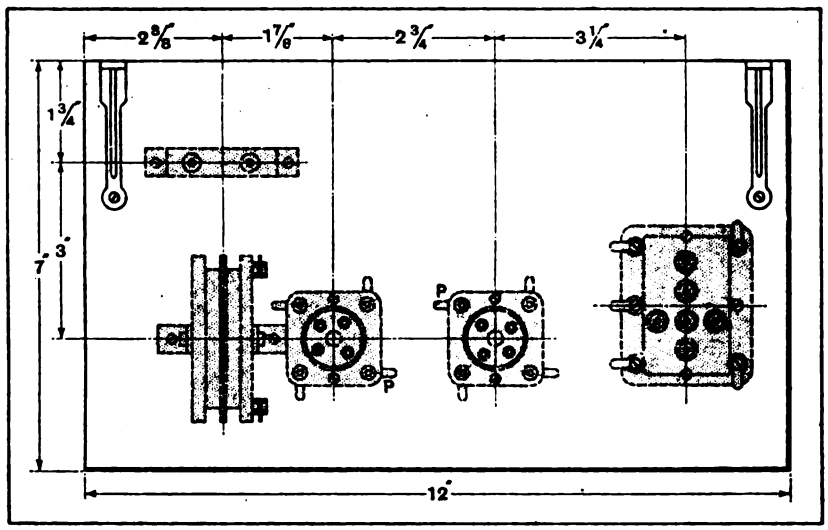

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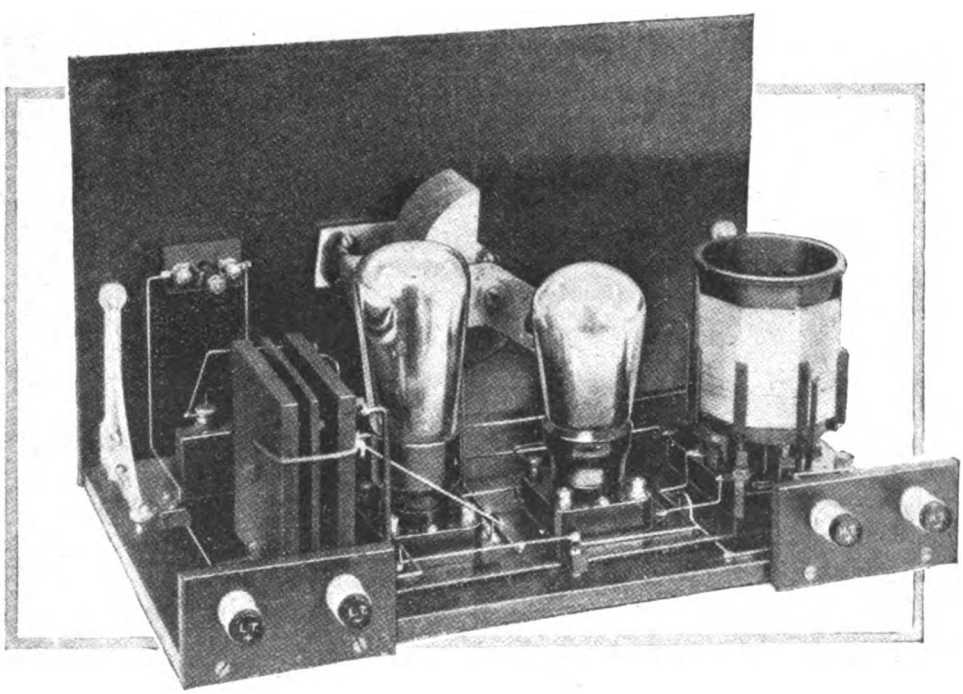

Rear view of the wavemeter The right-hand valve is the H.F. oscillator and the modulator is on the left.

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LIST OF PARTS.

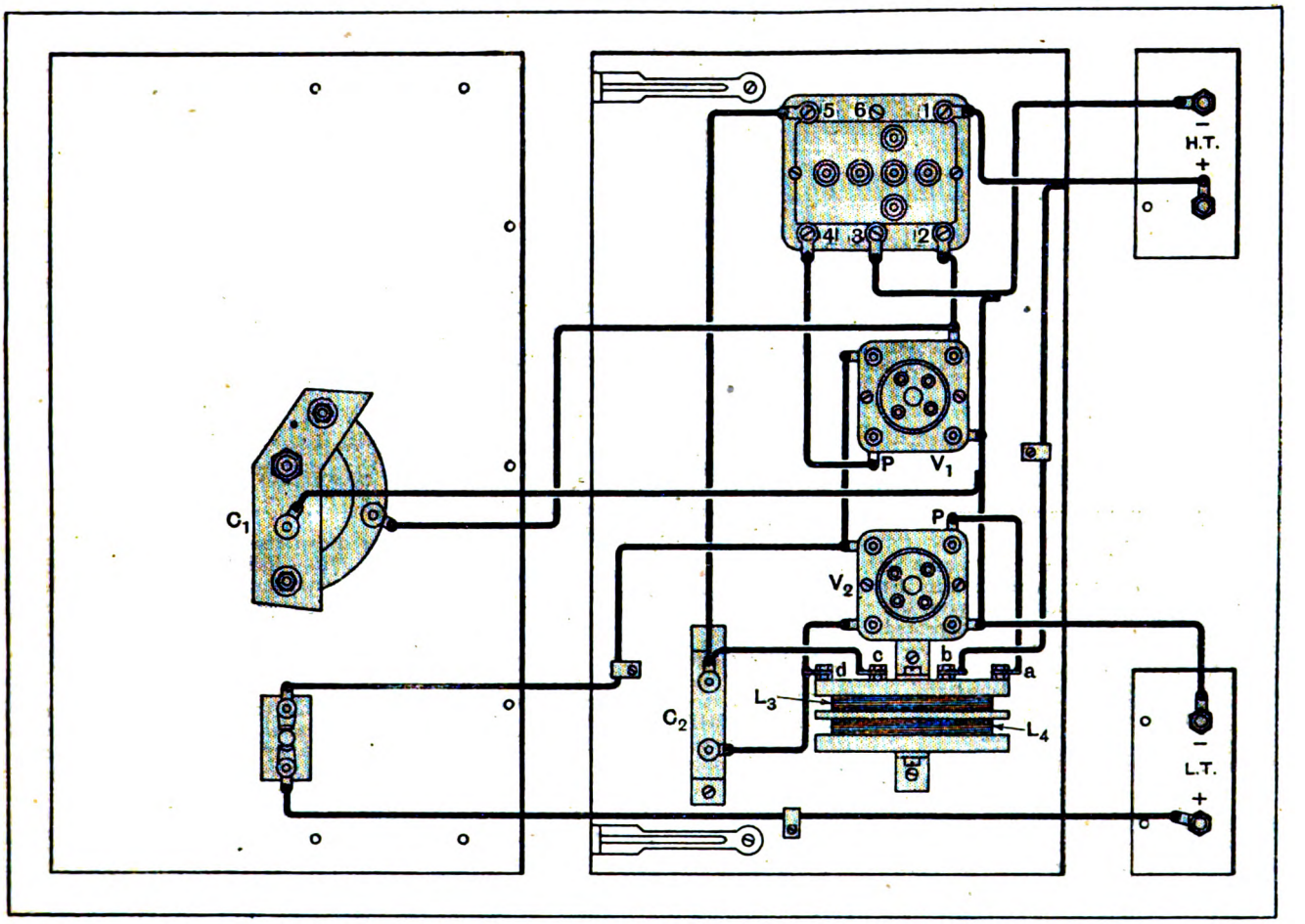
1 Ebonite panel, 12 × 7 × $\frac{3}{16}$ in.
2 Ebonite terminal strips, 3 × 1½ in.
2 Valve holders (Formo).
1 Variable condenser, 0.0005 mfd. Log. (Marconiphone).
1 Dial, 0–180°.
1 On and off switch (Bulgin).
1 Pair 3in. panel brackets (Camco).
1 former, 6-pin (Colvern Type R.P.).
1 Base, 6-pin, with terminals (Colvern).
1 Fixed condenser, 0.01 mfd. (T.C.C.).
4 Nickel-plated terminals (Belling-Lee).
6 ozs. No. 40 enamelled wire for modulator coil.
Quantity No. 26 and No. 34 D.C.C. wire, Sistoflex, ebonite, screws, etc.

Approximate cost, excluding valves, £2 8s.

the L.T. negative end: that is to say, from the bottom of the coil in the physical sense. Both coils are wound in the same direction.

It was mentioned earlier that a 36-volt battery will be required; actually the working H.T. voltage is slightly less than this, and will probably vary with different terminal and the high-tension battery, or between pins 3 and 5 on the coil base.

The calibration of the wavemeter will be a tedious job, unless a logarithmic condenser is fitted, but it can be achieved by making use of the measured wavelengths of some of the more important B.B.C.



Wiring plan of the baseboard and panel.

valves. The original model was fitted with a Marconi Osram H.L.210 as H.F. oscillator, and a Mazda G.P.210 as modulator. This arrangement worked very nicely with 24 volts H.T. If the modulator part of the unit is functioning correctly, it will be possible to hear the modulating frequency by connecting a pair of telephones, or a loud speaker, between the H.T. positive and Continental stations published from time to time in these pages.

A logarithmic condenser of the type used in the model, however, solves all our difficulties, since it is possible to redraw the calibration chart given by making one check reading on a station whose wavelength can be relied on, and engraving a short line on the panel as an

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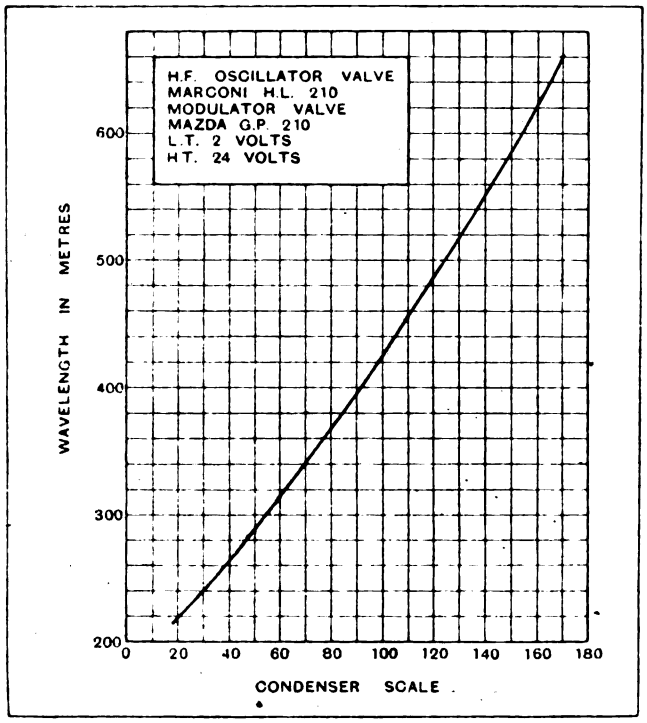
Modulated Wavemeter.—

indicator. For example, 358 metres (2LO's wavelength) corresponded to the 76-degree mark on the condenser dial of the model. A 0-180 scale is adopted. Another check wavelength would be 482.3 metres (5GB); this corresponds to the 118.5-degree mark on the condenser dial. The procedure is as follows.



Calibration chart taken from a standard wavemeter and using the valves and condenser mentioned in the text.

Calibration by Station Settings.

Accurately tune-in whichever station is the most convenient, and strictly limit the input to the set, either by means of a series condenser or a short indoor aerial. Wait until an interval occurs in the transmission, and then take a "snap" reading with the wavemeter. Refer to the chart and mark a line, lightly at first, on the panel, so that this corresponds with the dial setting for the particular wavelength chosen; the chart should be prepared beforehand, of course. The following table has been prepared, since it may be difficult to reproduce the chart from the one given here, owing to the small scale.

Condenser divisions on a 180° dial.	Wavelength (metres).
20	218
40	264
60	315
80	368
100	425
120	488
140	551·5
160	622

Before engraving the line deeply, it would be wise to take one or more check readings on stations of known wavelength and make certain that the wavemeter is in agreement.

TRANSMITTERS' NOTES.

Russian Stations.

Mr. A. Lambourne has kindly sent us a further list of Russian stations in the first district, from which we give the following, which have not yet appeared in the Radio Amateur Call Book :—

EU 1AL (ex 14RB), M. Smirnovsky, Omsk.
EU 1AM (ex 27RB), M. Kotelnokov, Novosibirsk.
EU 1AN (ex 30RB), M. Pavlyucheiko, Habarovsk.
EU 1AO (ex 72RB), M. Solomin, Biysk.
EU 1AQ (ex 29RW), M. Selezner, Tomsk.
EU 1AR (ex 60RW), M. Pivovarov, Omsk.
EU 1AS M. Sheptunov, Novosibirsk.

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Belgian Transmitter.

ON4HL, M. H. Thomas, is transmitting from 16 Boulevard des Martyns, Ghent, with a Mesny circuit, and an input of 8 watts, and will welcome reports from B.R.S. stations, which should be sent to him direct to save time.

oooo

Nationality Prefixes.

With reference to the note on page 613 of our issue of June 12th, our correspondent in Ceylon now informs us that the postal authorities have allotted amateur stations in that country the prefix VS, followed by the figure 7 to distinguish them from stations in the Malay States, which have the same prefix.

The following nationality prefixes should be added to the list previously published :—

RW—Persia (in place of RV), **ZK**—Cook Island **ZM**—Samoa, **ZP**—Paraguay.

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Temporary South African Call-Sign.

Mr. T. M. Yule (ZU6C) is temporarily in Rhodesia, and has been allotted the call-sign VQ2ND; his address is c/o Anglo-American Corporation, N'dola, Northern Rhodesia.

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New Call-signs and Stations Identified.

G2AW (ex 2AHX), W. F. C. Geraghty, 5, Benson St., Norton, Stockton-on-Tees.
G2CJ S. Townsend, Barnwood House, Gloucester, transmits on 7,000 kC. band and will welcome reports.
G2NM G. Marcuse, Dunedin, Caterham Valley, Surrey. (Change of address.)
G5NC H. Osborne, 77, Barrett Rd., London, E.17.
G5PO H. J. Pollard, c/o 35, Beresford Ave., Bebington, Cheshire. (Change of address.)
G5SL (ex 2AZD), W. H. Slough, 46, Station Rd., London, N.3.
G5ST R. R. Morrison, Spring Grove, Kilbarchan, Johnstone, Renfrewshire. (Returns to old address.)
G6KA K. F. Hardie, 117, Evering Rd., London, N.16. (Change of address.)
G6QF A. M. Robertson, The Tower, 5, Burford Rd., Whalley Range, Manchester.

BOOKS RECEIVED.

The Admiralty List of Wireless Signals, 1929, including direction-finding stations, land stations communicating with ships and aircraft, wireless beacons and fog-signals, meteorological and time signals, with extracts from the General Regulations under the International Convention of Washington, in so far as they are applicable to ships and aircraft, and from the special regulations affecting warships issued by various foreign governments. Compiled by the Hydrographic Dept., Admiralty. Published by H.M. Stationery Office and sold by J. D. Potter, 145, Minories, E.C.3. Price 6s. 6d. net.

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Wireless Echoes of Long Delay, by Prof. P. O Pedersen, Principal of the Royal Technical College, Copenhagen. Pp. 48, with 12 diagrams. Published (in English) by A. F. Höst and Sön, Copenhagen. Price Kr. 2.40.

oooo

On the Lichtenberg Figures, Part III, The Positive Figures, by Prof. P. O. Pedersen. Pp. 137, with 36 diagrams and 28 plates. Published (in English) by A. F. Höst and Sön, Copenhagen Price Kr. 10.

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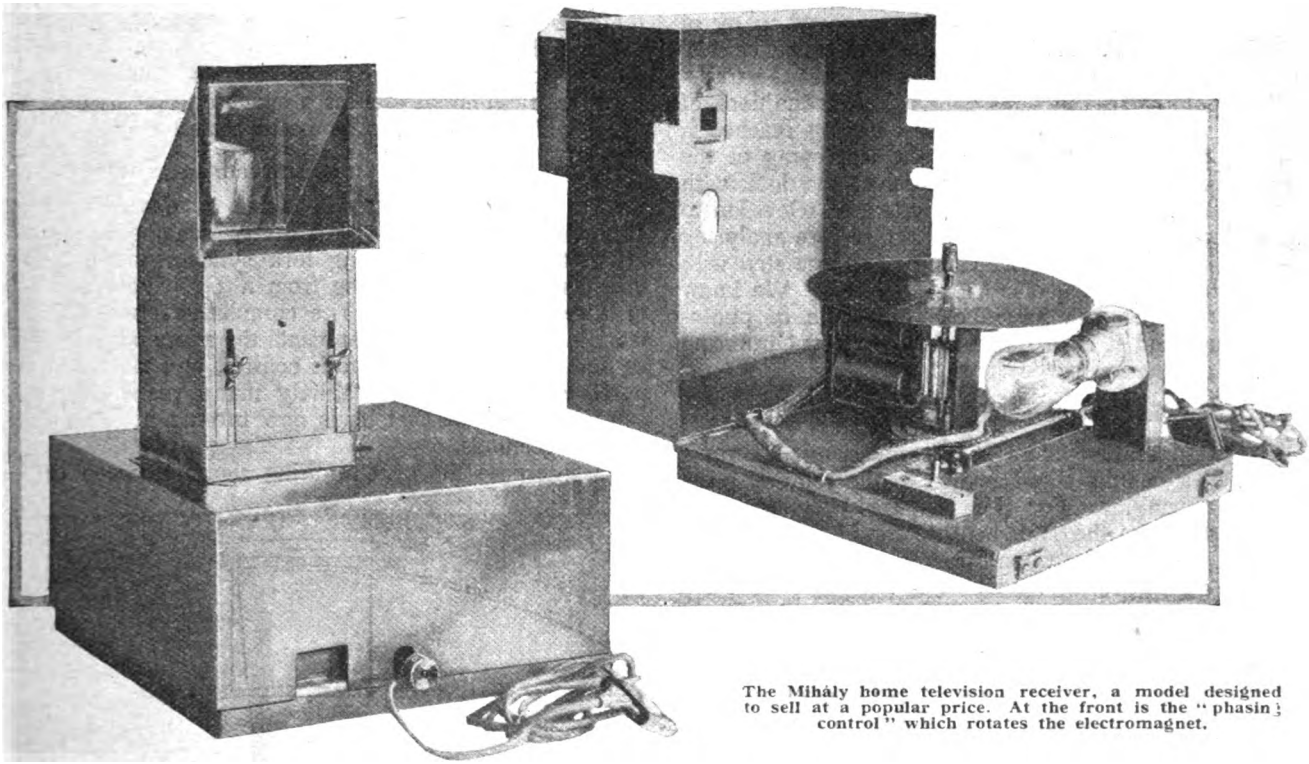
With any new development a high standard of perfection is not expected at the onset. To accomplish the aim while giving even crude results is an achievement that must be encouraged and heralded with appreciation. From this standpoint technical progress in the field of both television and picture telegraphy has been carefully recorded in these pages, rigidly avoiding prejudice on the one hand, yet on the other distinguishing between extravagant claims and well-founded inventions that will bear scientific investigation.

TELEVISION by the Mihály System

First Description of a New Receiver Shortly to be Seen in this Country.

AS long ago as March, 1924, there appeared in *The Wireless World* a detailed description of the research work then being conducted towards the achievement of a practical system of television by Denes von Mihály. His experiments dated back to 1913, and he claimed his first success in June, 1919. Much has been heard from Germany during recent months concerning this system of television which, it is claimed, possesses commercial potentialities. It is through the courtesy of the inventor that the writer has been privileged to examine the receiving equipments of this system and which Herr Mihály described and discussed in every detail. We have seen that after close investigation support has been given to the Mihály inventions by the German Post Office, and by their co-operation television transmissions have been taking place from the 4 kW. broadcasting station at Witzleben.



The Mihály home television receiver, a model designed to sell at a popular price. At the front is the "phasing control" which rotates the electromagnet.

Television methods, as we know them to-day, are extremely simple compared with the complex conditions which the radio amateur is called upon to study in the use of valve receiving sets. For the moment we are interested only in the television receiving apparatus.

Scanning Disc and Neon Lamp.

As with other systems, this depends upon a rotating disc with holes near its edge arranged as a single turn of a spiral. Readers are familiar with the purpose and design of such a disc. The holes are viewed through an aperture roughly equal in width to the arc between successive holes, the depth of the aperture being the difference in radius between the hole nearest the circumference and that nearest the centre. Immediately behind the disc and coinciding with the outline of the aperture is the cathode plate of a neon tube. This plate is caused to glow with varying luminosity by the changing currents of the output of the receiver. Thus,

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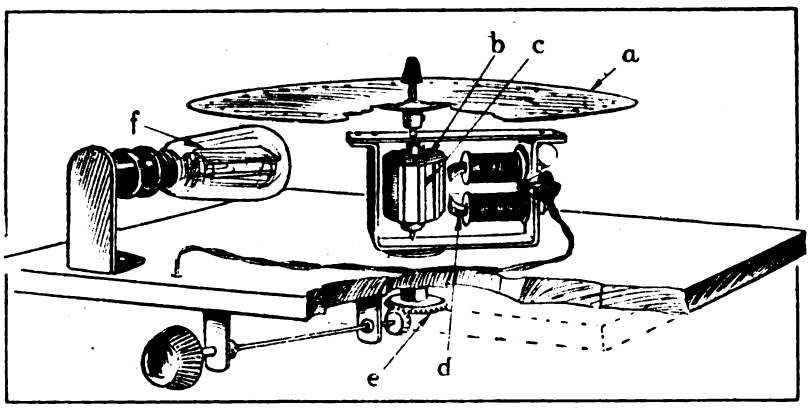
Television by the Mihály System.—

when the cathode is viewed through the holes in the rotating disc, a picture is formed by the process of causing the cathode to glow when the holes take up positions representing the white portions of the image.

Without describing the precise form of apparatus used at the transmitter, it is obvious that the object must be "scanned" and analysed into small areas, the light values of which are eventually conveyed to the neon tube at the receiver. The extreme sensitiveness



Constructional details of the receiver. (a) Ebonite disc with 30 holes forming a single spiral, (b) drum carrying 10 iron segments (c), (d) electromagnet energised from 50 cycle A.C. supply mains, (e) phasing correction control, (f) neon lamp deriving current from a rectifying valve connected to the output of the radio receiver.

of the modern photoelectric cell has removed many of the difficulties met with in the design of the transmitter, and for the Mihály system it is claimed that the transmitting equipment functions with normal conditions of lighting. Photocell and neon lamp having reached a state of perfection permitting of the conveying of the light values from transmitter to receiver, we look with critical interest in any proposed system of television to the methods employed for causing the picture analysing apparatus of the transmitter running in close step with the picture assembling disc at the receiver. We know how these difficulties have been overcome in photo-telegraphy, and it is in the merits of the synchronising gear that television succeeds or fails.

Mains Synchronising Unsatisfactory.

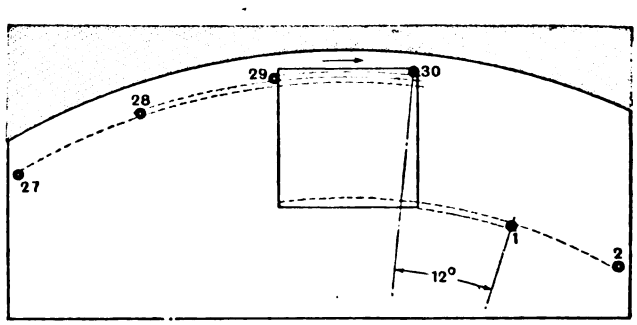
In the apparatus before us the revolving disc must be run at a definite speed related to the rotating parts at the transmitter. For this purpose a cylinder has been mounted on the shaft beneath the disc. It carries ten iron bars which, when rotating, move before the poles of an electromagnet which is energised from the alternating current supply mains. A 50-cycle supply would thus energise the magnet one hundred times a second, and in attracting the bars would revolve the disc at a definite speed, depending upon the frequency of the supply and the number of bars, giving in this case ten revolutions a second. This arrangement of synchronising was described in the Mihály system of 1924 and, known as the phonic wheel method, it has appeared in modified form in many systems of picture telegraphy.

For television broadcast, phonic wheel synchronising is unworkable owing to discrepancies in the frequency of the supply. This is at once appreciated by considering the effect on successive holes as they cross the aperture in forming a single image, assuming an error in the supply frequency as small as 2 per cent. In this case where each transverse line on the object is traversed in $\frac{1}{300}$th second a single hole of a 30-hole disc will have crossed the aperture in $\frac{1}{10.2 \times 30}$ seconds. A 30-hole disc sweeps an angle of 12° between successive holes, but with the 2 per cent. error an angle of 12.24° will be traversed at the receiver corresponding to 12° at the transmitter. In the passing of 30 holes, therefore, the 2 per cent. error still remains and gives the cumulative error of 367.2° rotation in place of 360°. An image 12° in width therefore possesses a displacement error of no less than 7.2° in a single revolution, or in the space of time $\frac{1}{10}$th second. Before a single image is completed its square formation becomes spread out to a wide parallelogram, and in the course of a second the ten images have become spread out in the form of a spiral extending over nearly quarter of the rotation of the disc. This point has been explained at length to show conclusively that the small errors met with in supply frequencies rule out this method, excepting, perhaps, where transmitter and receiver have mains common to them both. Even in these circumstances a synchronising frequency of 50 cycles is too low to be usefully employed.

"Inter-line" Synchronising.

In a small booklet which is issued, describing the Mihály apparatus, it is stated that where supply mains are not available a tuning fork synchroniser is provided intended for working from a 4-volt accumulator or three primary cells. The cumulative error arising from local synchronising prevents the adoption in home equipment of the simple fork control, and as this proposal was described by Mihály many years ago, we can safely assume that he is now turning his attention to new methods.

To interpose the synchronising signal between each



The revolving disc is seen through the square aperture and immediately behind is the neon tube. With 30 holes in the disc, the image is divided into 900 points of varying light value.

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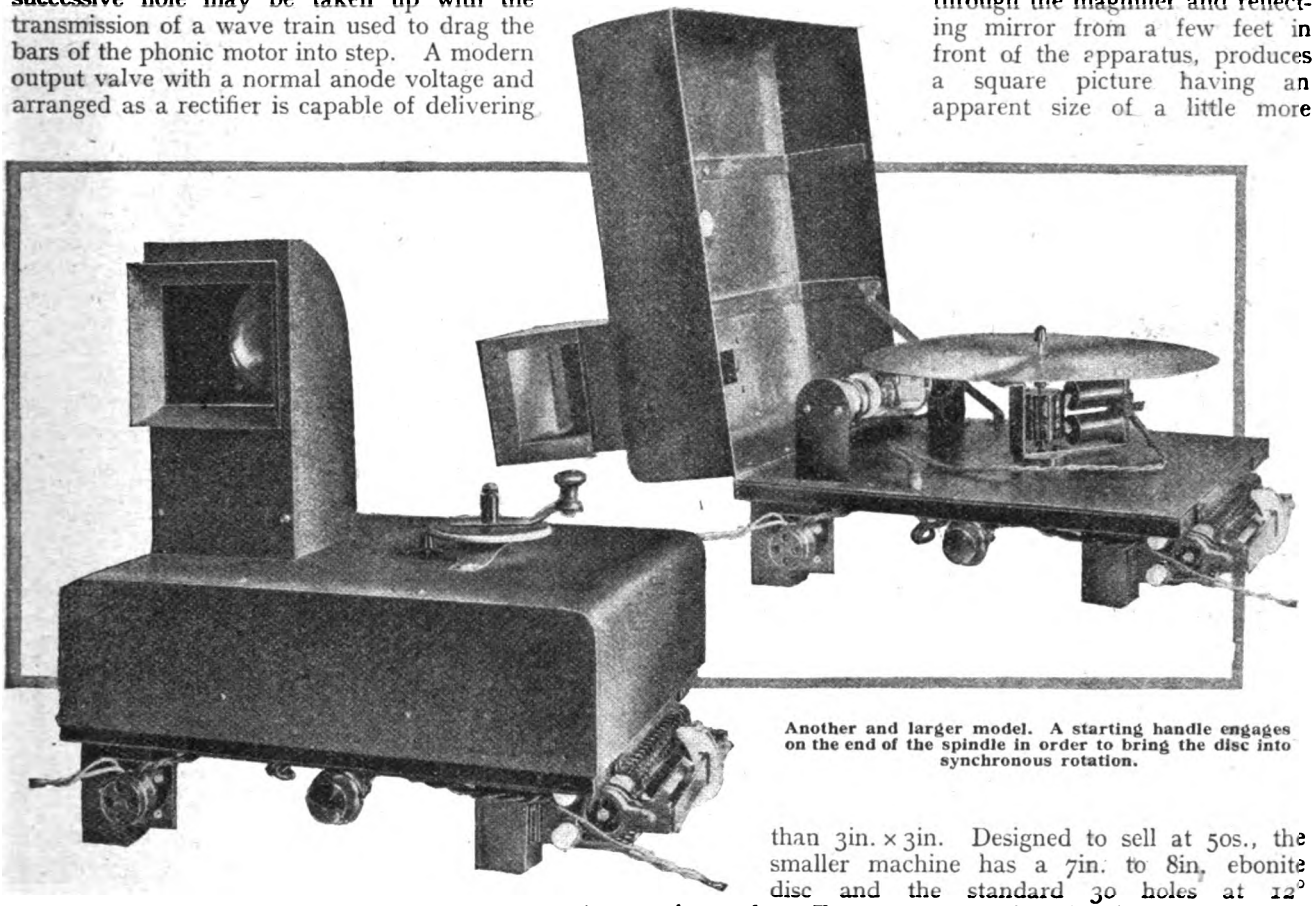
Television by the Mihály System.—

successive traverse of the object at the transmitter is a logical suggestion. With the 30-hole scanning disc and its 12° image, some 3° or 4° rotation between each successive hole may be taken up with the transmission of a wave train used to drag the bars of the phonic motor into step. A modern output valve with a normal anode voltage and arranged as a rectifier is capable of delivering an output of almost a watt, which applied intermittently for 25 per cent. of the time of rotation would, no doubt, alone serve to keep the almost frictionless mounted disc in rotation.



Another and larger model. A starting handle engages on the end of the spindle in order to bring the disc into synchronous rotation.

Neon Lamp Problems.

We now turn to another problem, that of the neon lamp which is required to glow to full brilliancy with the energy available in the anode circuit of an output rectifying valve. No great difficulty is experienced, assuming the use of a L.S.5 type with its associated high voltage anode current supply. In the Mihály system an important claim is made to the production of a new lamp capable of working when the available anode voltage does not exceed 150 and taking a current of only 5 mA. Attention might also be given to that property of the neon lamp in which the potential across the electrodes required to produce the glow may be appreciably higher than that at which the glow ceases. This property has no doubt received attention in the design of the lamp and by creating non-linear conditions in the associated circuit.

In the television receiver machines, shown in the accompanying illustrations, of which there are two types following in detail the description given here, magnifying lenses are fitted giving an enlarged virtual image. With the larger model a 30-hole disc gives an image a little over 1in. square. This, when seen through the magnifier and reflecting mirror from a few feet in front of the apparatus, produces a square picture having an apparent size of a little more than 3in. × 3in. Designed to sell at 50s., the smaller machine has a 7in. to 8in. ebonite disc and the standard 30 holes at 12° intervals. To compensate for the image which is formed behind a smaller aperture, greater magnification is provided so that the image appears similar in size to that of the larger type apparatus.

Because a phonic motor is not self-starting, a friction drive is fitted to the cover of the larger model, while with the smaller machine a knurled knob provides for rotating the disc up to a speed where the motor can drop into step with the supply frequency. Another control, acting through bevel pinions or worm wheel, swings the magnet about the motor axis. This, the "phasing control," brings the disc into correct relationship with regard to the aperture, so that the formation of each single picture starts simultaneously with each complete analysis of the object of the transmitter. A rheostat to be seen on the large instrument is for the purpose of accommodating the magnet winding to the mains voltage.

As it is understood that the Mihály system is considered to be sufficiently advanced for a broadcast television service, it will be possible to give more details when the complete equipment makes its appearance in this country. In the meantime we await with interest the results of a demonstration. F. H. H.

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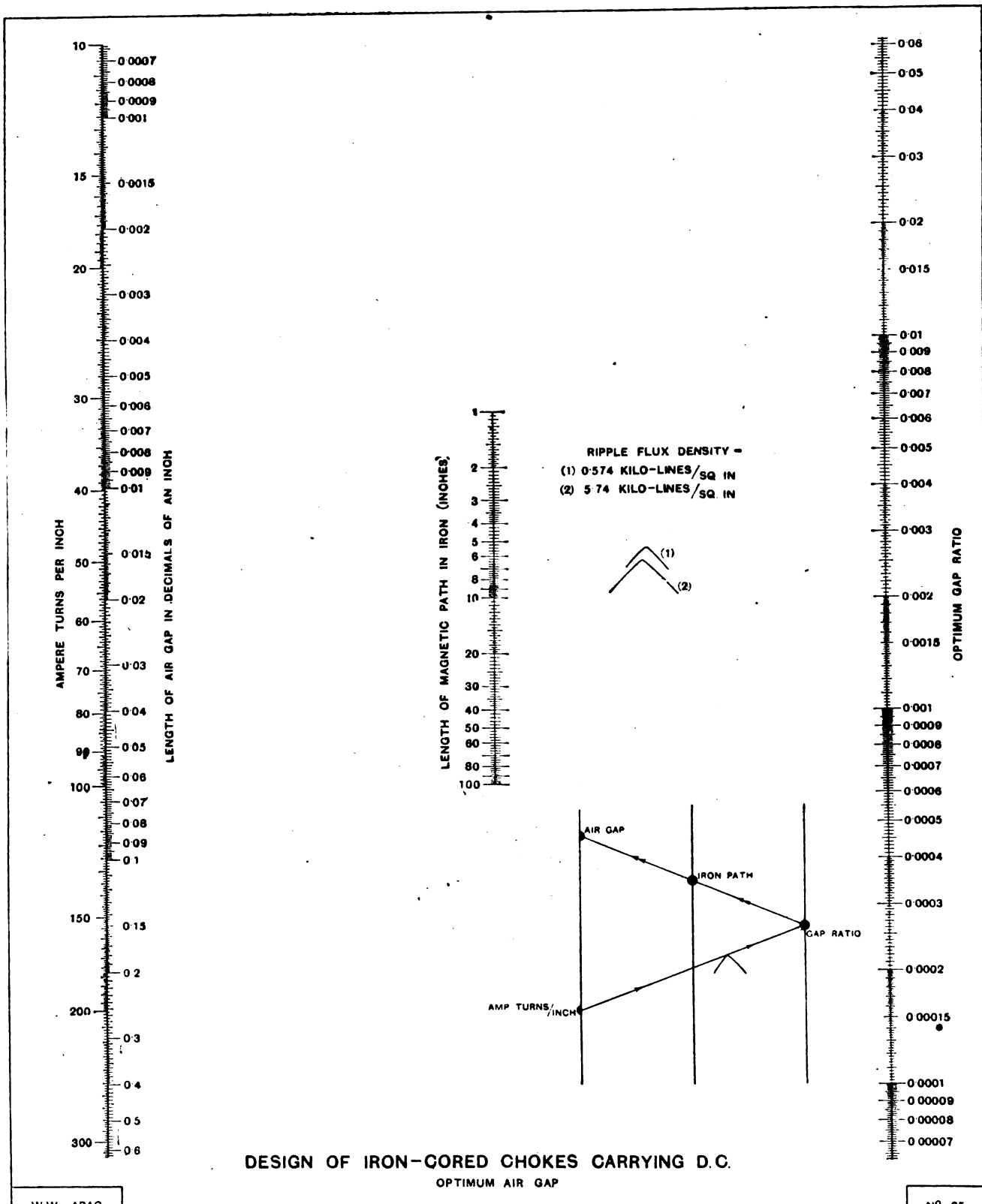

USEFUL DATA CHARTS (No. 25c). The most satisfactory width of air gap for an iron-cored choke can be obtained from this abac. For further explanatory notes reference should be made to last week's issue

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DESIGNING THE L.F. AMPLIFIER

The Input to the Power Stage.

By T. R. LUPTON, M.Sc.
(of the Ferranti Radio Research Laboratories).

(*Concluded from page 666 of previous issue.*)

WE now come to the consideration of the input of the power stage. The writer prefers transformer as against resistance coupling, the main reason for this being, theoretically, that large transients including atmospherics, etc., can choke up the grid condenser, and this may last sufficiently long to be annoying to the critical ear. In practice, resistance capacity is not quite so foolproof as transformer coupling for getting best results, although by judicious design it can certainly be very excellent; for the description of an ambitious resistance amplifier with a good measured characteristic the reader should refer to an article entitled the "All Electric Amplifier" which has recently been published in *The Wireless World*.[1] Let us assume, therefore, that we intend using transformer coupling to the power valve. If push-pull has been decided on, then, without doubt, transformer coupling is the most convenient. For this a transformer having a centre-tapped secondary is the best thing to use.

An ordinary transformer can be furnished with an artificial centre tap by placing across its secondary two equal grid leaks in series, the centre point being taken to the grid bias as shown in Fig. 2. This, however, is not advisable for the following reason. The secondary of a good transformer has an enormously high impedance. When one places across it even such a high resistance as a grid leak, and when the secondary has an e.m.f. induced in it, the grid leaks will take a small amount of current. This current is certainly very minute, but the fact that it flows through the enormously high impedance of the secondary means that there is a voltage drop, i.e., the voltage applied to the grids of the power valves is not as high as the e.m.f. generated in the secondary.

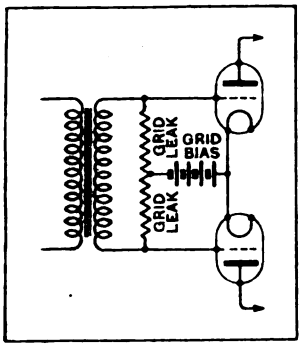

Fig. 2.—A means of obtaining an electrical centre tap to an untapped intervalve transformer. Amplitude distortion may arise from loading the secondary.

This in itself is not a disadvantage, but the trouble is that the current through the grid leaks varies according to the voltage across the transformer, so that the voltage drop in the transformer secondary varies also. Thus the output voltage becomes non-proportional to the input voltage across the primary, setting up what is strictly an amplitude distortion. A practical objection to this method is that if one buys two grid leaks of nominally the same value it is very unlikely that they will be exactly similar, hence one power valve grid has much more voltage applied to it than the other, with the result that full advantage is not obtained from the use of two valves.

[1] *The Wireless World*, June 19th, 1929.

A Plea for Calculation of Grid Swing.

In the penultimate stage, in spite of what many people have thought, even a small power valve is not necessary. Assuming as before that two PX.650 valves are being used in push-pull, which requires twice as large a grid swing in order to overload than does either a single valve or valves in parallel, we will consider grid swings, and by dint of ordinary multiplication

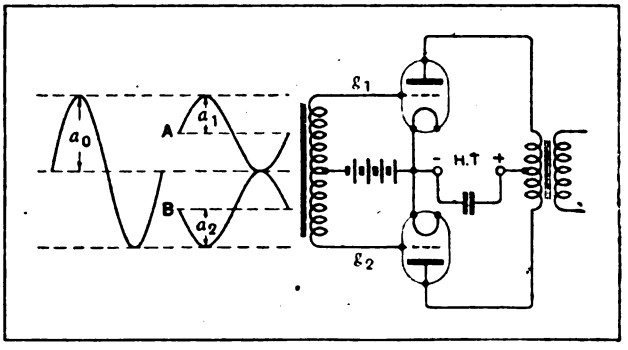

Fig. 3.—Graphical representation of the application of a signal grid swing to two valves in push-pull.

or division prove that the power valve is not necessary in the previous stage. With 200 volts on the anodes two PX.650 valves in push-pull will need a grid bias of −40 volts. Now it must be borne in mind that the centre-tapped secondary transformer performs the function of splitting the signal into two halves, as shown diagrammatically in Fig. 3, one half being applied to one valve as at A, while the other is applied to the other valves as at B. Thus in order to overload the valves a total peak swing, shown as a_0 in Fig. 3, which will just overload the valves, equals 80 volts.

Assuming a transformer ratio of $3\frac{1}{2}$, then the voltage across the primary of the input transformer will be 80 divided by $3\frac{1}{2}$, that is, approximately 23 volts. Now suppose that in the penultimate stage we place an ordinary L.F. valve of a type with an impedance of 7,500 ohms. This valve with a good transformer will give a very flat curve for practically the whole of the normal audible range, so that we can say that it is quite an orthodox type of valve for this position. Such

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Designing the L.F. Amplifier.—

a valve will have an amplification factor of 15. Thus in order to produce 23 volts across the primary of the transformer in its anode circuit a voltage of 23 ÷ 15 would have to be applied to its grid, that is, approximately 1.7 volts. Normal conditions for this valve would be 140 to 150 volts H.T., with a grid bias of −3 volts. Thus there is ample margin of safety against overloading this valve, and the desirable condition would be reached of the output stage overloading long before there was any such tendency with the penultimate stage. The word "desirable" is used here advisedly because in a quality set it is practically imperative to use a milliammeter in the output stage in order to keep a check on the emission of the power valves, and since the set has been designed so that this is the point where overloading first occurs, the milliammeter by the movement of its needle shows immediately when overloading is present.

Choice of Detector.

Having therefore decided upon the valve which will perform the dual function of accepting the large available grid swing, whilst at the same time not overloading the transformer, or, in other words, not reducing the primary inductance of the transformer by virtue of saturating magnetically the iron core, we can proceed to a study of the first valve in the low-frequency chain, that is, the detector valve, together with its coupling to the succeeding valve. The two popular methods of rectification are (a) cumulative grid, and (b) anode bend.

Discussions have in the past been numerous as to which of these two types is the "better." Without going deeply into the subject the "pros and cons" may be summarised thus. Cumulative grid rectification is very sensitive, and is useful, in fact, it is almost indispensable to the man who is building a set which is intended for the reception of distant stations. For really good quality of telephony reception a cumulative grid rectifier must have a comparatively critical value of voltage applied to its grid. On the other hand, anode bend rectification dispenses with the grid condenser and leak, thus saving the constructor a matter of four or five shillings. It is normally styled an inefficient method of rectification. This is very true for small grid swings: in fact, signals which are inaudible with an anode bend rectifier can be made quite audible by using grid leak rectification.

If a comparatively large signal is fed to the grid of an anode bend rectifier, rectification becomes very good, and there are other advantages which can most easily be discussed by referring to the valve characteristic shown in Fig. 4. This is the one usually included with the valve, where anode current is plotted vertically, grid voltage being plotted horizontally, the curve being taken for a stated value of anode voltage. In order to obtain anode rectification, the grid bias would be set at a value which would bring the initial condition of the valve down to the point X on the curve. Now suppose that a *small* signal is applied to the grid (as in Fig. 4 (a)), this would vary the grid voltage between the limits A and B. There would thus be an increase of current from a value C to D, and during the negative half-cycle a decrease from C to E. The mean increase would then be of some such value as F. It must be noted that, owing to the curvature about X, rectification has occurred, i.e., there has been an increase in the mean current to the anode of the valve, but the positive half-cycles have not been very much greater than the negative half-cycles.

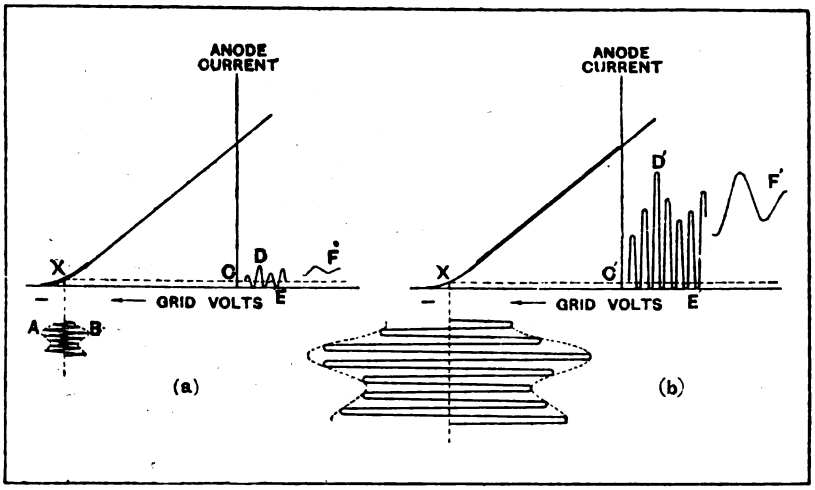

Fig. 4.—In (a) the application of a weak signal to the bend in the anode characteristic is shown. When a large signal is applied to an anode bend detector, the modulated envelope is applied to the straight part of the characteristic as in (b).

In the next place, let us assume that either more high-frequency amplification has been added, or, alternatively, a stronger station has been tuned in, resulting in a large input to the detector shown in Fig. 4 (b), where the same valve characteristic is repeated. The initial point is still X, but now the positive half-cycles raise the anode current to a point D', whereas the negative half-cycles can only result in a minute diminution to E'. There is thus a very large difference between the increases and decreases of current, or, in other words, a good efficiency of rectification, resulting in a change of mean anode current to a value F'. This is not the only advantage accruing. With the small input signal, the signal oscillated round the bend, which is shown thickened. This bend is such that the valve impedance is very much greater than that stated on the leaflet supplied with the valve, and care therefore is required in the choice of the coupling unit to be used in the anode circuit of the valve, but when a large signal is used, as in Fig. 4 (b), the crests of the high-frequency positive half-cycles enclosed by the dotted line envelope occur solely on the straight part of the characteristic (again shown thickened), so that the variation due to modulation is traversing the characteristic where the valve has nearly its normal impedance.

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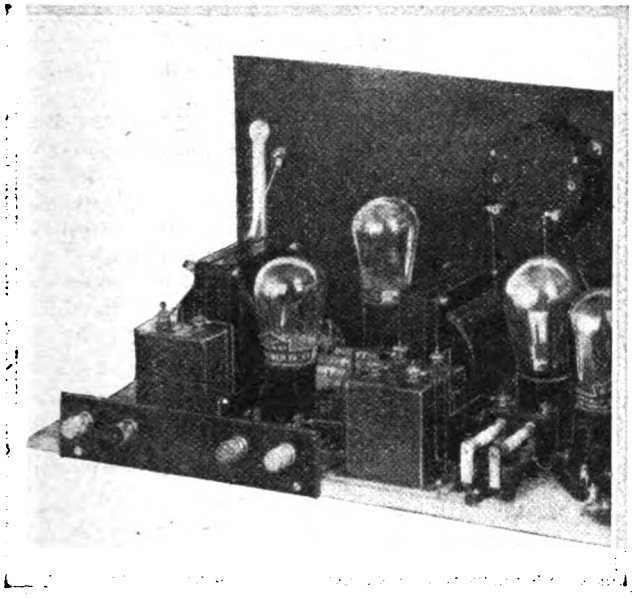
Designing the L.F. Amplifier.—
In this case one's choice of a coupling unit is not limited as previously. In addition, the output, even for comparatively large modulations, is proportional to the input, whereas, due to the curvature, this was not so in the case of the small signal.



The output stage of a receiver incorporating two valves in transformer push-pull.

It is thus seen that the choice of rectifier depends upon the magnitude of signal which can be applied to the grid of the detector, but there is no doubt that for quality work the anode bend method is far more popular.

Coupling between Detector and First L.F. Valves.

The limitations of resistance coupling following anode bend detection are such that, first, an attempt to obtain a large fraction of the valve's amplification when using a so-called R.C.C. valve is usually accompanied by serious high note loss, due to the effects of a large working capacity. Secondly, if the shunting of the higher audio frequencies is minimised by reducing the by-pass condenser, rectification efficiency falls off, and the only palliative is a valve of lower impedance having a low-value coupling resistance, while still retaining a by-pass condenser of sufficient capacity to ensure good rectification.

Unfortunately, this expedient entails a reduction of overall amplification, a condition which is regarded by many as a disadvantage.

Sufficient has been said to show that a really good resistance-capacity stage is a compromise. On the other hand, as pointed out earlier, an anode bend rectifier when used with a large input signal has only a little more than its nominal impedance, so that, if the valve be suitably chosen, it can be followed by a transformer. The only condition to observe is that the nominal impedance of the valve should be of the order of 10,000 ohms. The limits are set by the fact that if a very low impedance is used precautions have to be adopted to avoid large currents flowing through the primary of the transformer; if a high impedance is used the frequency amplification curve of the stage is spoiled because the impedance of the transformer at very low frequencies is not appreciably greater than that of the valve. The following equation which is sufficiently accurate for everyday use, but is not mathematically rigid, shows the relation between amplification and frequency for transformer coupling:—

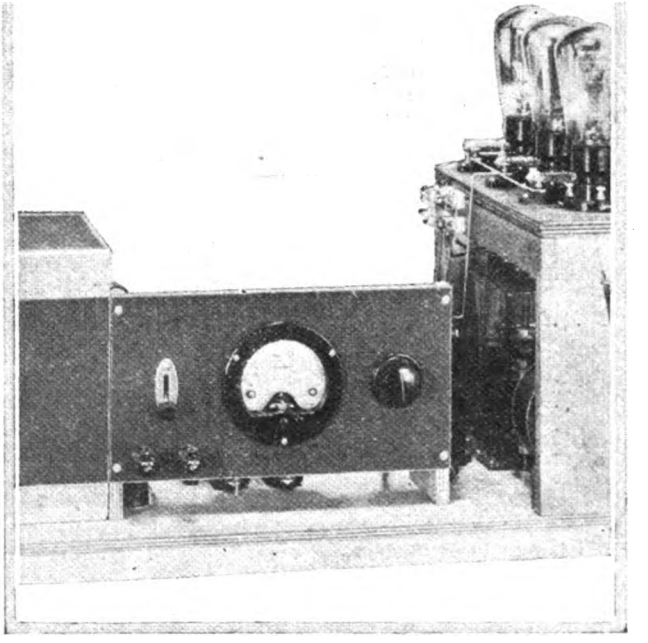
$$\text{Amplification} = M \times \text{Ratio of transformer} \times \frac{Z}{\sqrt{R_o^2 + Z^2}}$$

M = Amplification factor of valve.
Z = Impedance of transformer primary.
R_o = Valve impedance.

Since the transformer primary impedance varies with frequency, it is seen that if Z is very much greater than R the amplification becomes M multiplied by the ratio. Because of this fact the transformer primary impedance must be kept much higher than the valve impedance at all frequencies; when this condition is satisfied an even amplification curve with respect to frequency is obtained.

Volume Control.

Perhaps the most commonly used method of volume control is that of de-tuning the H.F. circuits. From a quality point of view this could be an advantage, for, if one condenser is de-tuned slightly downwards whilst another is de-tuned in the opposite direction, the loss of high frequencies due to selective circuits is greatly counteracted. Where selectivity is desired this de-tuning is a disadvantage, so some other means of volume control has to be found. There is also the objection in the case of anode bend rectification that with the large input signal just described, pre-detector volume control



The detector panel of *The Wireless World* "Schools Demonstration Receiver." Note the milliammeter which reads the average rectified output.

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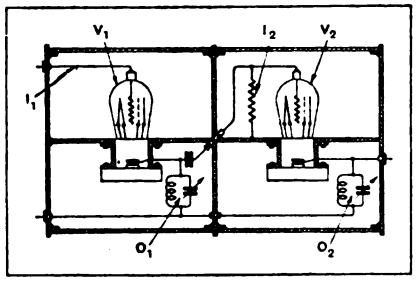
Designing the L.F. Amplifier.—

cannot be used with a normal aerial signal as it is necessary to keep up high-frequency amplification in order to load up the detector. The simplest method of volume control and the most satisfactory is to arrange a variable high resistance across the primary of the transformer in the anode of the detector, a resistance having a maximum of the order of 100,000 ohms being suitable for this purpose. A similar method can be used in resistance-capacity coupling where this resistance actually becomes an anode resistance, but it is usually difficult to obtain a variable high resistance of this order which will carry the anode current required by the valve. It was pointed out earlier in this article that a resistance of any description placed across the secondary of a transformer is a disadvantage, but a resistance placed across the primary has a definite advantage in that it improves the amplification against frequency curve of the detector plus transformer stage.

The sequence of operations for obtaining really good quality with a receiver of this type is to tune in a station at good strength, that is, until one obtains if possible a reading on a milliammeter placed in the anode circuit of a detector (valve impedance 8,000-10,000 ohms) of 0.5-1.0 milliamp. This ensures that the modulated part of the high-frequency wave is actuating the valve over the straight portion of its characteristic. This with the full amount of low-frequency amplification will overload the output stage, so that the next operation is to adjust the low-frequency amplification by means of the variable resistance just mentioned, thereby obtaining the requisite volume without overloading and consequent distortion. With such a set worked under the conditions of suitably large input and optimum H.T. and the necessary grid bias one can be confident of obtaining results entitling one to criticise the transmission of any station—an ambition which seems common to all wireless enthusiasts of the present day.

SCREENING VALVE AMPLIFIERS.

Although the use of screen-grid valves avoids reaction due to capacity coupling between the internal valve electrodes, it does not prevent reaction effects due to the proximity of external connecting leads and components in the input and output circuits respectively. For this additional screening means are necessary. One such arrangement recently designed by the British Thomson-Houston Co. (Patent No. 285020) is illustrated in the figure.



Complete screening by two-section compartments.

Two H.F. valves are enclosed in a common metal casing, which is subdivided into four compartments, each housing the leads and components of the separate input and output circuits, 1_1, 1_2, and 0_1, 0_2 respectively. The valve holders are mounted below the transverse partition panel in such a way that each valve is readily accessible without disturbing the existing circuit connections.

oooo

EARTHING-SWITCHES.

The best form of earthing-switch is one in which a direct aerial-to-earth connection can be made outside the building, so that there is no danger of a lightning-discharge taking place inside the house. At the same time, it is obviously convenient to be able to control the earthing-switch from inside the room where the receiving set is situated.

The drawing shows a convenient arrangement of this type (Patent No. 300780). The outside fitting consists of a rotary drum D mounted on the external wall of the house and operated by a Bowden-wire control from a lever L located inside. The drum D is fitted with a spiral spring S, which normally causes a curved contact strip C to bridge the aerial and earth terminals A, E so as to form a direct short-circuit. By moving the lever L into the position shown, this bridge contact is broken, and the down-lead terminal A is simultaneously brought into direct connection with the end of the Bowden-wire control. The latter then acts as a lead-in conductor from the aerial to the receiving set, through a wire A1 connected to the spindle of the control handle L.

oooo

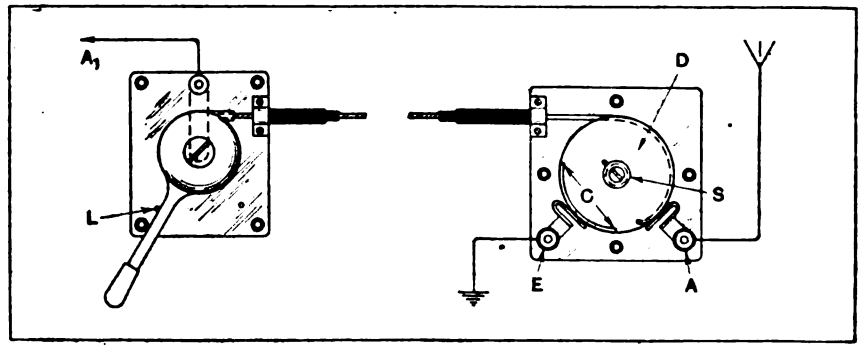
EXPONENTIAL HORNS.

In a well-designed loud speaker horn (a) the proportion of available mechanical energy in the diaphragm converted into sound should be a maximum, and (b) this proportion or factor of performance should be the same for all the audible frequencies. The requirement under (a) depends upon the area of the initial throat opening of the horn, whilst that under (b) depends upon the rate of expansion of the bore and the overall length of the horn.

In the exponential or logarithmic type of horn, the area of the bore is designed to increase by a constant percentage per unit length, progressively from throat to month. Theoretical considerations show that the smaller this percentage increase is kept the more uniform is the loading on the diaphragm for various frequencies. Further, in order to minimise end reflection from the mouth of the horn, the flare should be as large as possible. These requirements obviously involve a long horn.

The Igranic Co. have recently evolved a new principle of design in which the above-mentioned features are secured in a horn of comparatively small overall length. Instead of keeping the percentage increase in bore area a constant factor, as in the standard logarithmic horn, it is made to increase progressively per unit length from throat to mouth.

PATENT NOVELTIES.



Indoor Bowden-wire control of an outside aerial-earth switch.

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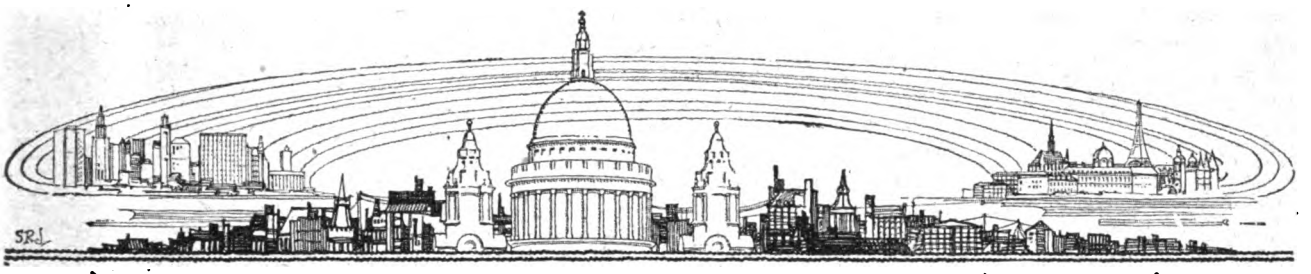


CURRENT TOPICS

Events of the Week in Brief Review.

ANOTHER FLAG DAY.

A proposal for a radio flag day for the provision of wireless in the local workhouse is under consideration at Hitchin.

oooo

BRITISH LICENCE INCREASE.

The number of receiving licences in force at the end of May was 2,760,878. This shows an increase of 20,000 over the figure for April. In addition, 14,830 licences have been issued without charge to blind listeners.

oooo

OFFICIAL GRATITUDE TO FRENCH AMATEURS.

Amateur transmitters in France who have made important contributions towards short-wave research are to be relieved of all wireless taxes, writes our Paris correspondent. The announcement was made at the recent Conference of French amateurs in Paris.

oooo

PREMIER TO BROADCAST FROM U.S.A. ?

The Prime Minister has received an invitation from the Chicago Federation of Labour to broadcast in the autumn over the American network of stations. He is promised an audience of 100,000 and "a chain hook-up that will enable radio listeners to hear you throughout America and Europe."

oooo

S.A. BANS BROADCAST ADVERTISEMENTS.

The South African Broadcasting Company has decided to discontinue the inclusion of advertisements in the programmes. Commenting on the decision, *South African Wireless Weekly* remarks: "The absence of these advertisements will not even be noticed after the first two nights, for we have all got so used to them that we never take the slightest notice of them."

oooo

WHEN THIEVES FALL OUT . . .

By the use of a secret wireless station, a gang of swindlers in Berlin are reported to have defrauded bookmakers of sums estimated at between £5,000 and £10,000. According to the Berlin correspondent of *The Daily Telegraph*, the clandestine receiver has been used to pick up the results of French races before they were generally available in Germany. The fraud was detected when the members of the gang quarrelled amongst themselves.

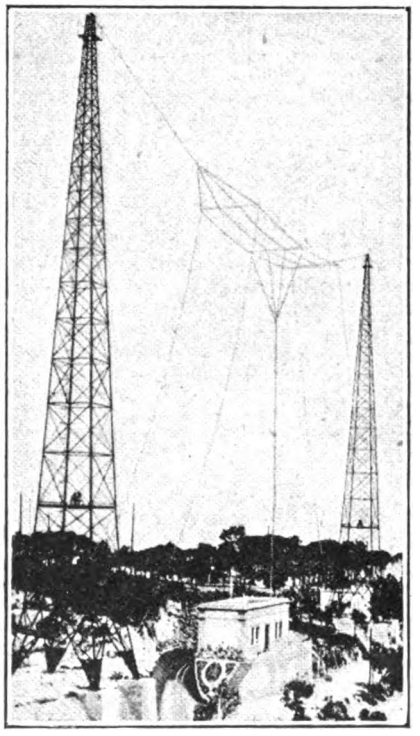
RADIO DIFFUSION.

The Union Internationale de Radiophonie is to change its title to Union Internationale de Radiodiffusion. The next session will be held in October at Barcelona. In the spring of 1930 a meeting will take place at Budapest.

oooo

RADIO LABORATORY FOR THE BLIND.

"La Radio aux Avengles," a French organisation for the relief of the blind, has initiated a movement for providing blind wireless enthusiasts with a laboratory in which they can construct sets and receive special instruction from qualified radio engineers. The scheme also provides for the distribution of a radio journal printed in Braille.



BILBAO, one of the Spanish broadcasting stations which have escaped the economy axe. It occupies a fine site overlooking the Bay of Biscay.

NONE SO BLIND . . .

A listener fined £5 and costs at the Belfast Police Court for owning and operating a wireless set without a licence pleaded ignorance of the law. He had been a listener since 1923.

oooo

S.A. BEAM BOOM.

A Johannesburg report states that beam shares are booming. Applications representing upwards of £900,000 were received in response to the recent issue of £48,694 in the Wireless Telegraph Co. of South Africa.

oooo

SHORT WAVES FROM SIBERIA.

For the benefit of trappers in Polar regions the Soviet Government is planning the erection of a short-wave station at Turukhansk, Siberia, on the edge of the Arctic Circle. The transmissions will include news bulletins and weather reports.

oooo

TWIN WAVE TRANSMISSIONS IN ITALY.

The high power broadcasting station now being constructed by the Marconi Company at Rome will broadcast on two wavelengths simultaneously, viz., 254 and 80 metres. The transmissions will be intended primarily for the Italian colonies in Africa.

oooo

POSTMEN AND PIRATES.

Dublin postmen are reported to have launched a successful protest against a rule requiring them to give information concerning the whereabouts of unlicensed wireless sets. Through their official union the postmen pointed out that they wished to remain on friendly terms with householders. The Parliamentary Secretary to the Post Office has now assured the Union that postmen are "under no compulsion whatever" to report pirates.

oooo

THE WILY OSCILLATOR.

At a convention of the Northumberland and Durham Group of Radio Associations, held at the North-East Coast Exhibition on Saturday last, June 29th, it was moved "that this Convention considers that the system of dealing with complaints respecting oscillation is cumbrous and inadequate."

Another motion on the agenda ran: "That this Convention considers that in view of the fact that the B.B.C. are en-

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tirely dependent upon the licence payers for its income, the said licence payers are entitled to more detailed information as to the disbursement of the funds in the administration of the B.B.C."

oooo

BRITISH INDUSTRIES FAIR, 1930.

New quarters have been found for the London section of the British Industries Fair, 1930, in the specially reconstructed Olympia at Hammersmith. The Fair will be held from February 17th to 28th, and it is expected that, as in previous years, the radio industry will be well represented.

oooo

FIELD DAY FOR ALL.

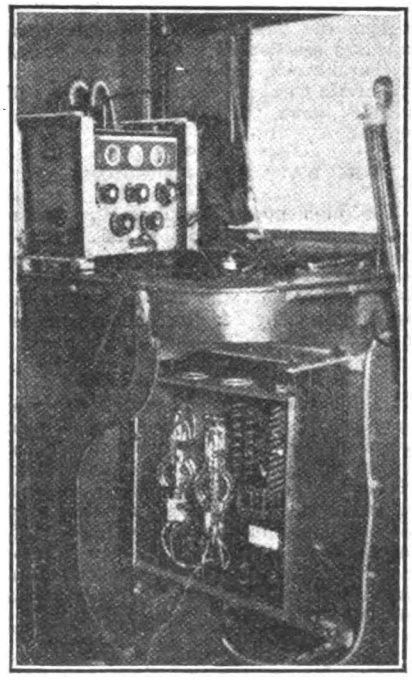
Members of any radio society are invited to take part in a Direction-finding Field Day—the last of a series—to be held at Elstree, Herts, on Sunday next, July 7th, by the Golders Green and Hendon Radio Society. The requirements are a portable set capable of reception on 150 metres, a pair of headphones, frame aerial, compass, map and means of transport. Several valuable prizes are offered.

Full particulars are obtainable from the Hon. Secretary, Lt.-Col. H. Ashley Scarlett, D.S.O., 60, Pattison Road, London, N.W.2.

oooo

LOUD SPEAKERS AT R.A.F. PAGEANT.

Nearly sixty Marconiphone loud speakers will be employed for public address purposes at the R.A.F. Pageant at Hendon on Saturday, July 13th. Five special 32-valve power banks will comprise the last amplifying stage, and the total number of valves used will be nearly 180. The total H.T. current will be 6,000 milliamperes at 350 volts, while on the L.T. side 350 amperes will be taken.

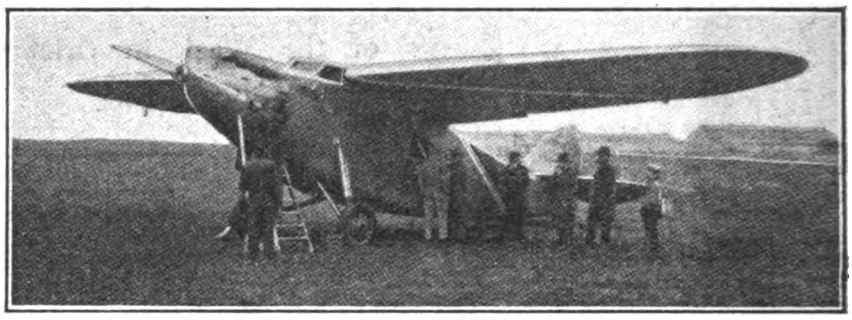


FRENCH AIRCRAFT WIRELESS. The radio equipment, fitted with Dario valves, used on board the "Yellow Bird," shown above.

PATENT LAW: ANY COMPLAINTS?

The Patents Committee, under the chairmanship of the Rt. Hon. Sir Charles Sargant, has begun its investigations, and persons and associations who wish to submit suggestions or to give evidence before the Committee are invited to communicate with the Secretary, Mr. R. W. Luce, Industrial Property Department, Board of Trade, 25, Southampton Buildings, W.C.2.

The Committee was appointed by the Board of Trade to report whether any amendments in the Patents and Designs Acts or changes in the practice of the Patent Office are desirable.



A TRANSATLANTIC VICTOR. The "Yellow Bird," on which the French airmen, MM. Assolant, Lefevre and Lotti made their recent crossing of the Atlantic. The wireless equipment, which was in constant use throughout the journey, is seen below.

U.S. TEST PROGRAMMES FOR BRITAIN.

A new series of transmissions specially intended for reception in Great Britain in the early evening has been inaugurated by WGY's short-wave station, 2XAF, at Schenectady. The transmissions are carried out daily, except on Saturdays and Wednesdays, according to the following schedule: Sunday, 7.30 to 10.30 p.m., 15,340 kilocycles; Monday, 7 to 9 p.m., 13,660 kilocycles; Tuesday, 7 to 8 p.m., 15,340 kilocycles; Thursday, 7 to 9 p.m., 13,660 kilocycles; Friday, 7 to 8 p.m., 15,340 kilocycles. All time references are B.S.T.

oooo

CANADA'S WIRELESS HOTEL.

The first complete broadcast receiving equipment, combined with a local public address system, to be installed in any hotel in Canada, has just been placed in commission by the Canadian National Railways in the Chateau Laurier at Ottawa. The equipment includes a broadcasting studio occupying part of the eighth floor, 90 "points" in the public rooms and private suites for special microphones, loud speakers and pick-up apparatus, together with a portable signalling system with telephone communication for the control of programmes originating in the hotel. There is also a control board by means of which the hotel may be connected directly by wire with any one of the 11 broadcasting stations which the Canadian National Railways operate in Canada between Halifax and Vancouver.

oooo

WIRELESS WEB FOR SOUTH AMERICA.

In the international scramble for the development of South American communications a point has been scored by the United States, according to a New York message. All America Cables, a subsidiary of the International Telephone and Telegraph Corporation, has obtained wireless telegraph and telephone concessions in Ecuador, Peru and Columbia. The Columbian concession authorises the construction of a high power station at Bogota, with two additional stations on the Atlantic and Pacific coasts respectively.

oooo

NEW B.B.C. WAVELENGTHS.

Certain revisions in the wavelengths of the British broadcasting stations under the Prague plan were announced by the B.B.C. shortly before the plan came into operation on Sunday last. The following is a complete table of the British wavelengths now in use: —

Station.	Frequency in kilocycles.	Wavelength in metres (approx.)
Daventry (5XX)	193	1,553
Manchester	797	377
Daventry (5GB)	626	479
Glasgow	752	399
London (1)	842	356
London (2)	—	—
Cardiff	968	310
Aberdeen	995	301
Bradford	1,040	288.5
Bournemouth, Dundee, Edinburgh, Hull, Liverpool, Plymouth, Sheffield, Stoke, Swansea	1,040	288.5
Newcastle	1,148	261
Belfast	1,238	242
Leeds[1]	1,500	200

[1] 1,500 k.c. (200 metres) is not a British exclusive wave under the Prague Plan, but special arrangements have been made for its use by the Leeds transmitter.

oooo

REGIONAL BROADCASTING FOR SWITZERLAND?

The latest scheme for improving Swiss broadcasting calls for the erection of two high power transmitters, one at Sursee and the other at Moudon, in the south-western district of the country. The same plan contemplates the taking over of the existing stations at Geneva, Lausanne, Berne, Basle and Zurich, and for the construction of small relays at Sitten, Olten, St. Gall, Chur, in addition to one at Locarno, Bellinzona or Lugano. The entire system would be linked up by special telephone cables, thus permitting an interchange of local programmes.

As the *Plan de Prague* has allocated five exclusive wavelengths to Switzerland, it would be possible to use some of these as common waves on which the smaller and weaker relays could operate without causing any interference.

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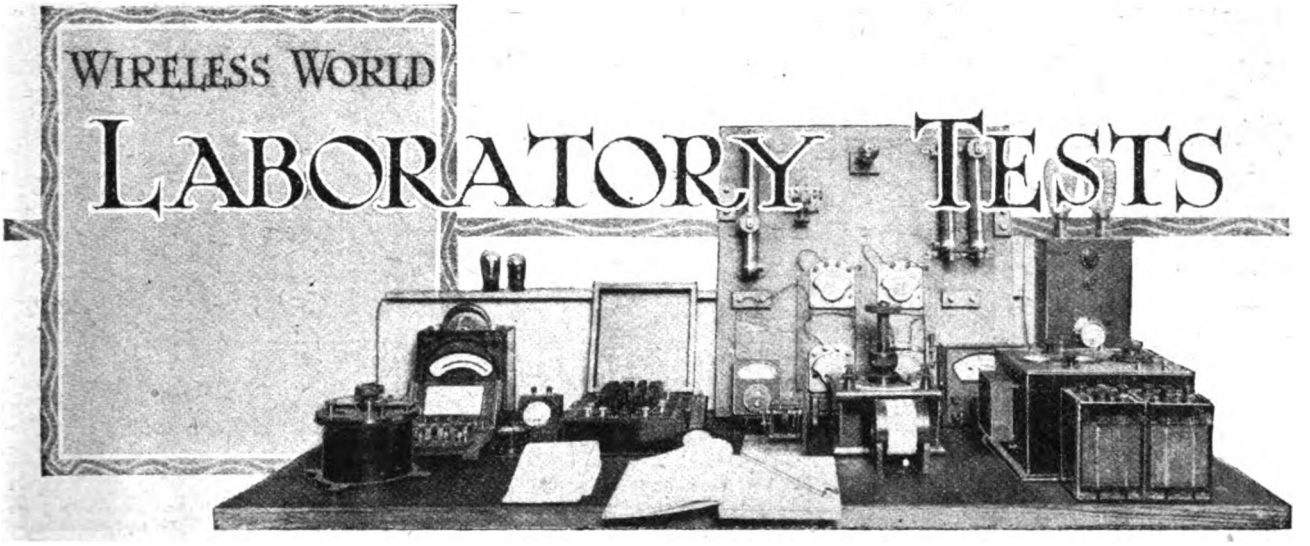
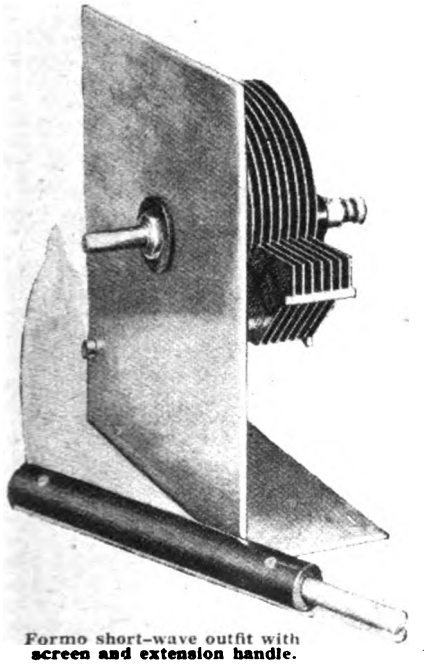


A Review of Manufacturers' Recent Products.

FORMO SHORT-WAVE OUTFIT.

This consists of a 0.00015 mfd. logarithmic type variable condenser, mounted on a vertical aluminium screen for fixing to a baseboard. An ebonite



Formo short-wave outfit with screen and extension handle.

extension handle 4in. long enables the condenser to be mounted close to the coils and well back from the panel, thereby totally eliminating all hand capacity effects.

The moving vanes of the condenser are supported at both ends, the two bearings being carried in moulded pillars with brass insets. Electrical contact to the moving vanes is made through the back bearing and not by means of a pigtail. This may give rise to noises on the very short wavelengths if the rubbing surfaces become dirty; however, during our tests there was no trace of scratch or other objectionable noises due to this method of making contact.

The screen is provided with an earthing terminal, and since this will normally be "earthed" it was connected to the moving vanes when measuring the capacity of the condenser. The minimum capacity was found to be 12 micro-microfds. and the maximum 0.000164 mfd.

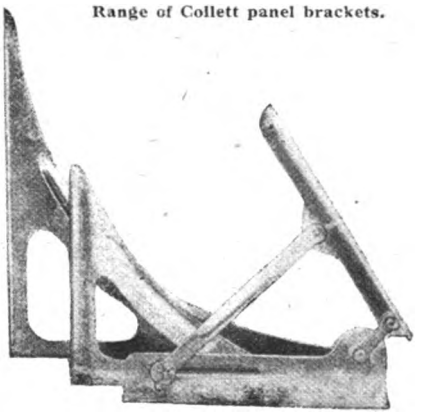
The outfit is made by the Formo Co. (Arthur Preen & Co., Ltd.), Crown Works, Cricklewood Lane, London, N.W.2, and the price is 10s. 6d. without dial.

o o o o

COLLETT PANEL BRACKETS.

These panel brackets are available in two kinds, fixed and adjustable. The fixed type are made in large and small sizes, measuring 3½in. × 3½in. and 6in. × 6in. respectively. The prices are 1s. 3d.

Range of Collett panel brackets.



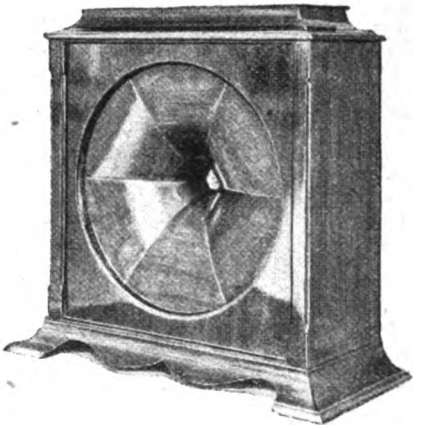
and 1s. 9d. per pair. The adjustable type measures 5in. × 5in., and enables the panel to be set at any angle between 60° and 90° with the baseboard. These are offered at 3s. the pair.

The makers are the S. H. Collett Manufacturing Co., 60, Pentonville Road, London, N.1.

o o o o

"REALISTIC" LOUD SPEAKER.

The range of loud speakers made by Messrs. W. H. S. Vincent, 72, Penton Street, Islington, London, N.1, under the trade name of "Realistic," has been augmented by a handsomely finished cabinet cone in polished mahogany, selling at £6 6s. The distinctively shaped diaphragm, built up from sections of thin



"Realistic" cabinet cone loud speaker in polished mahogany case.

veneer wood as described in these pages on November 14th last, is retained. An adjustable movement is fitted, which, when correctly set, gives good sensitivity.

A practical test on a high-quality amplifier revealed a slight tailing off in response at the upper and lower ends of the audible scale, but this was only in evidence when compared with a high-class moving-coil instrument. The middle register is well brought out.

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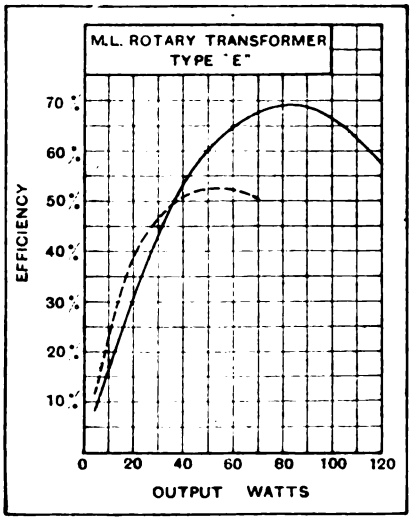
M-L ROTARY TRANSFORMERS AND MOTOR GENERATING SETS.

The success of the small anode converters has led to a demand for a larger machine capable of delivering an output suitable to operate public address amplifiers, radio gramophone sets for dance purposes, and similar requirements. The "E" type rotary transformers are rated to give 100 mA. at 400 volts, but our tests showed that the machines are capable of a much larger output, the voltage being higher than the rated value.

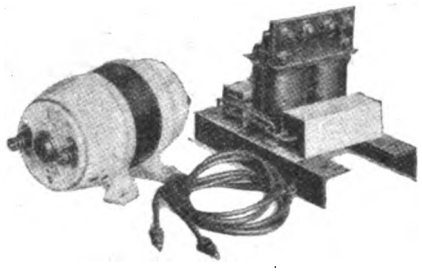


Efficiency curves of the Type "E" rotary transformers.

The models dealt with in this review are wound for 12- and 210-volt inputs, but machines can be wound to suit any input voltage between 12 and 250. The 12-volt model is ideal for use with mobile amplifiers, since it can be run off the car accumulator. If especially required, the machines can be wound to give an A.C. output which is approximately sinusoidal, but in this case the maximum watts available will be less than for a D.C. output.

Efficiency and voltage regulation curves were taken for the "E" type machines, and these are plotted on the accompanying graph. The full line curves refer to the 210-volt model, and the broken line curves to the 12-volt model. An efficiency of 70 per cent. was obtained at 85 watts output (670 volts, 125 mA.) from the 210-volt model, while the maximum efficiency was recorded with the 12-volt model when 55 watts (400 volts, 130 mA.) were drawn from the output end. The efficiency was found to be 52.5 per cent. These figures are highly satisfactory for small machines.

The machines are made by the M-L Magneto Syndicate, Ltd., Victoria

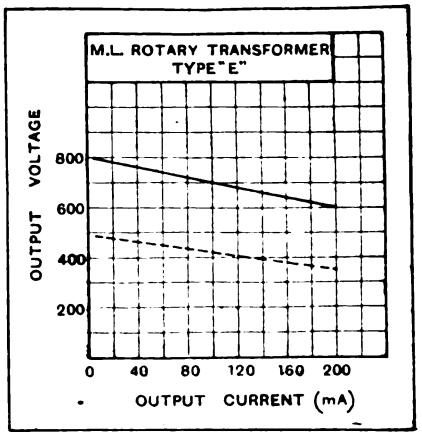


M-L rotary transformer Type "E" and smoothing circuit.

Works, Coventry, and the price has been fixed at £12 5s. for either type.

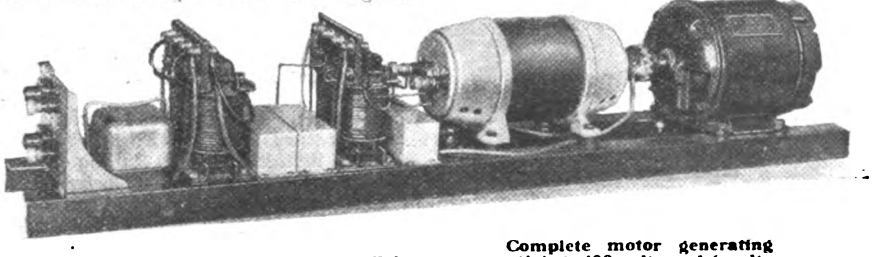
A special smoothing equipment, consisting of two chokes wound on a massive core, with 4-mfds. condensers assembled on a stout iron frame, is supplied for use with these generators. The measured D.C. resistance of each choke was found to be 45.5 ohms; the voltage drop across these will be negligible. The smoothing equipment is offered at £4 5s.

These machines can be obtained giving high- and low-tension outputs and driven by a separate motor. The motor-generat



Voltage regulation curves of M-L rotary transformers Type "E."

ing set illustrated comprises a 220-v. A.C. motor coupled to a Type F generator delivering 400 volts at 200 mA. at one end and 6 volts at 6 amps. at the other. It includes smoothing equipment, both



Complete motor generating equipment fitted with Type "F" generator giving 400 volts and 6 volts.

H.T. and L.T., and automatic "cut-out" to guard against damage due to short-circuit of the output. The complete equipment is mounted on a substantial bed plate made up from stout angle iron, and the price has been fixed at £40.

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BULGIN MULTI-COIL.

This is a dual range coil particularly suitable for use with screen-grid valves, since by adopting the tuned anode circuit, or tuned grid arrangement with parallel feet *via* a choke to the plate of the valve, simplified switching is possible. The type "A" is the aerial-grid unit, and the type "B" the H.F. coil.

The device consists of a 3in. diameter former carrying the medium-wave coil, wound in two sections, on the outside, while the long-wave portion is wound on a slotted former mounted inside the 3in. tube and with its axis at right angles to that of the medium-wave coil. The long-wave coil is centre-tapped and electrically connected between the two sections of the medium-wave coil.

A simple push-pull three-point switch short-circuits the loading coil. Three

Bulgin multi-coil with wave change switch incorporated.

terminals are fitted, 1 and 2 being connected to the outside ends of the medium-wave coil, while the terminal marked "X" is the electrical centre tap for both long- and medium-wave coils.

An "A" type unit was submitted for test, and when connected to a standard receiving aerial, with a 0.0001 mfd. condenser between the aerial and the centre tap, tuned from 215 metres to 620 metres on the medium waveband and from 1,060 metres to 2,570 metres on the long waves. A 0.0005 mfd. variable condenser was used. The makers give the ranges as 250 to 550 and 1,000 to 2,250 metres respectively.

The price of "A" and "B" coils is 15s. 6d. each. Another type ("C") is available also at the same price; this includes a reaction winding. The makers are Messrs. A. F. Bulgin and Co., 9, 10, 11, Cursitor Street, Chancery Lane, London, E.C.4.

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By Our Special Correspondent.

H. G. Wells at the Microphone.—Bigger Studio Audiences ?—Western Regional.

A Talks Coup.

Mr. H. G. Wells making his first appearance before the B.B.C. microphone should be an interesting phenomenon to us all, whether we be "dyed-in-the-wool radio hams," set constructors, or merely gentle listeners. The famous publicist is definitely booked to appear at 9.15 p.m. on Wednesday next, July 10, and I gather that Savoy Hill is so delighted over the *coup* that the question of "censorship" which usually arises has not been discussed. It is known, however, that Mr. Wells' talk will be based on his recent speech in the German Reichstag on the subject of world peace.

oooo

Tyranny of the Talks Manuscript.

In securing a speaker of Mr. Wells' calibre the B.B.C. deserves every congratulation, more especially in view of the fact that the creator of Mr. Britling is one of the illustrious few who have not hitherto disguised their unwillingness to broadcast.

Perhaps we are on the eve of a new era in broadcast talks in which, incidentally, the manuscript will be less of a tyrant than at present. Nowadays broadcast "talks" are not talks at all, but merely readings by people who, in many cases, have been endowed with most talents except elocution. The pity of it is that, if allowed to, they could *talk* with grace and distinction.

oooo

Sunday Morning Thanksgiving.

The Thanksgiving Service for the King's recovery, to be held in Westminster Abbey next Sunday morning, is to be broadcast from all stations of the B.B.C., including 5SW, the Empire short-wave station at Chelmsford.

It is expected that broadcast receivers will be installed in a number of churches to enable congregations to participate in the Abbey service.

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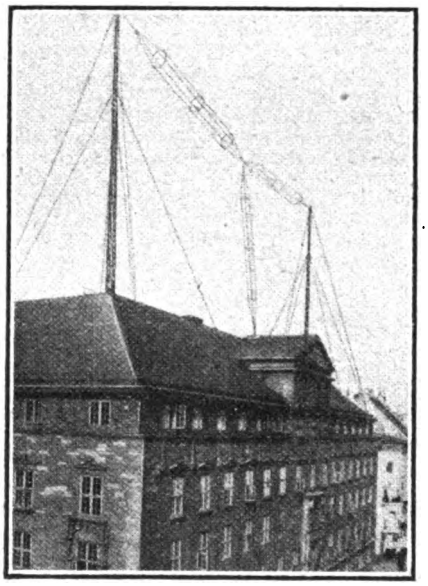
"Disclosure."

The play for broadcasting on July 11 from 2LO and 5XX is to be "Disclosure," and not Gerhardi's "Lord Brute," which was originally arranged. "Disclosure" is by O. Wyndham and Ivor McClure.

That Studio Audience.

It disturbs me to be told that the B.B.C. intends to enlarge the studio audience in the near future. The complicating factor about the studio audience is that it is always a scratch team, with no sense of the microphone and no time in which to learn studio manners. One batch of novices succeeds another, and as each is intoxicated by the novelty of the experience, laughter



NORWAY'S BROADCASTING CENTRE. A new view of the Oslo station, which transmits on 493 metres.

and applause swamp the performance and the listener takes pot luck.

A friend of mine suggests that the "studio audience" should consist of a group of hirelings, in another room, who would clap and laugh throughout the programme. Their efforts would be "faded-in" and "faded-out" at appropriate moments.

oooo

Bristol and the Western Regional Station.

Bristol, it seems, is doomed to disappointment in regard to the Western Regional Station. Ever since broadcasting began, the citizens of Bristol have strenuously demanded a station of their own, and in view of the fact that a site for the new Western Regional is to be chosen in the course of a few months the plea is being renewed. The B.B.C. has decided, however, that the Western Regional must be located "somewhere in Wales," probably near Cardiff. But Bristol may expect that an independent studio will be provided from which local programmes can be relayed to the regional station. It is probable that many other important cities and towns will have studios of their own.

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"Flivvers" at the Proms.

Already a skeleton programme has been mapped out for the B.B.C. Promenade Concerts. The eight weeks' season will open at the Queen's Hall on Saturday, August 10, under the conductorship of Sir Henry Wood. A feature of this year's "Proms." will be a number of new British works, the composers represented including Arnold Bax, Arthur Bliss and Herbert Howells. In some cases the composers will conduct. Two revolutionary innovations will be Honegger's "Rugby," describing the game in terms of music, and an American symphony—"Flivver 10,000,000," by Frederick S. Converse—described as "a joyous epic for orchestra." I gather that it will be a hymn to mass production.

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B.B.C. Takes the Hint.

I am glad to note that the B.B.C. has acted promptly in removing a programme anomaly to which I drew attention in a recent issue. For some time past Belfast listeners have been tantalised by Mr. Harvey Grace's Saturday talks from London on "Next Week's Music." These were broadcast from 2BE in common with other B.B.C. stations despite the fact that very little of the music referred to was included in Belfast's programme! In future, while Mr. Harvey Grace is giving his talk, Mr. E. Godfrey Brown, the musical director at Belfast, will discourse on music actually to be broadcast from that station.

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The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

SELECTIVITY AND QUALITY.

Sir,—A chance remark in a letter by Mr. C. W. Carr in an issue of some months ago, in which he speaks of "those many wireless enthusiasts who have plumbed the depths of sound wireless," reminded me of a problem in which very little advance seems to be made.

Whilst it is possible to obtain a very convincing reproduction from the *local* station by employing a moving coil loud speaker and a carefully designed low frequency amplifier, any attempt to obtain good reproduction on a set of high sensitivity, on the H.F. side (and consequently fairly high selectivity) ends in disappointment. I do not mean to say that it is impossible to obtain a station, some miles distant, with very fair success, but it is impossible to do justice to the capabilities of a modern loud speaker under such conditions. This of course is due to the mutilation of the side-bands in the high-frequency portion of the receiver. I should be much interested to hear the views of any of your readers on this subject, which is surely one of topical interest on the eve of the introduction of the regional scheme and the consequent necessity of selectivity in a receiver.

This seems to be a "depth" which could stand considerably more plumbing and most recent advances in receiver design (i.e., S.G. valves, low loss couplings, etc.), whilst doubtless excellent in their primary object tend to increase this defect.

I am quite aware that there are difficulties in the way, but if attention is attracted to this subject and interest created in it, radio designers may perhaps be stimulated to increase their activities in an attempt to solve this problem, and sensitivity and good reproduction may be made compatible.

London, S.E.13. R. L. SOPER.

AMATEUR STATUS.

Sir,—I must heartily congratulate you on the leading article in your June 19th issue, regarding the amateur status in this country. I am very glad you have taken it upon yourselves to voice the matter, and I trust it will be of some avail.

On several occasions your columns have proved the medium of reform. May they be so in this case.

Antrobus, Cheshire. J. SPEAKMAN (BRS 98).

Sir,—I wish to congratulate you more than heartily upon your leading article in the June 19th issue, and I am sure there are many others that think the same but will not trouble to write saying so. Regarding your last paragraph, of course, there is plenty of room, and might I suggest that you press for a band of one-metre width from, say, 12 to 13 metres and, whilst on this subject, why not press for the authorisation to use the 80-metre band which the Washington Conference gave to amateurs?

Thanking you very much indeed for your endeavours.

Burgess Hill, Sussex. "INTERESTED PARTY."

VALVE OUTPUT.

Sir,—The letters from Mr. Reeves and Mr. Bowsher are very interesting, and it is to be hoped that the valve manufacturers will adopt a standard system of calculating the power output of their valves.

If two valves are placed in parallel, then the effective impedance is halved and the output is doubled.

I am, however, not clear as to the case of two valves arranged in the so-called "push-pull" system. How does one calculate the maximum undistorted power output of two valves used in this manner? The effective impedance is doubled, I understand.

For comparative purposes three cases may be taken: (1) One PX.650 valve; (2) two PX.650 valves in parallel; and (3) two similar valves in push-pull, all with 200 volts anode voltage and −40 volts grid bias. The listed amplification factor is 3.5 and the impedance 1,750 ohms. "KEENTONO."

Blackburn.

MORSE INTERFERENCE.

Sir,—I notice that several correspondents who have written in recent issues on the above subject have taken it for granted that all Morse interference on medium-wave broadcasting stations is due to transmitters actually within the medium waveband.

In my experience, however, the strong harmonics set up by powerful wireless-telegraphy stations working on the long waves are responsible for a good deal of this interference.

The Air Ministry stations, GFA and GFB, seem to be particularly bad offenders in this respect, at any rate, as far as the London area is concerned. The former especially produces a number of remarkably strong harmonics within the 200-600-metre waveband which become painfully audible when they happen to heterodyne the carrier-wave of a distant broadcasting station.

On one evening recently, for example, I was able to read the whole of the evening shipping forecast from GFA with my set tuned to Radio-Belgique!

One appreciates, of course, that GFA and GFB conduct an important "meteo." service of forecasts and reports of value to shipping, etc., but steps might perhaps be taken to reduce the harmonic interference without seriously impairing the efficiency of the transmissions on their fundamental wavelengths. I understand that special attention was given to this matter (apparently with some success) in the case of the new transmitters installed some little time ago at Croydon Airport.

Wandsworth Common, S.W.18. W. OLIVER.

IT'S UP TO THE B.C.L.

Sir,—As a keen reader of *The Wireless World* since pre-broadcast days—when your journal was "the only one" for the amateur—I deprecate the allocation of the "Correspondence" page to so much destructive criticism of the B.B.C. policy and programmes

I assume that most readers of your paper have sufficient technical ability to bring their receivers up to date. The provision of a screen-grid H.F. stage would bring in most Continental stations worth having (and what could the B.C.L. desire better than Hilversum or Kalundborg as a suitable alternative to the occasions when the B.B.C. programme is dull?).

To jog along and grumble is like putting up with an old car and yet grousing at the limitations thus imposed. The radio licence fee of 10s. does not limit the listener to the B.B.C. programmes, and at all events the B.C.L. gets more for his money than did the old enthusiast in the days of the "Morse only" reception (*via* "crystal").

I would advise the B.C.L. to anticipate the regional scheme by having his receiver *modernised*, and thus in the meantime be able to select his own programmes instead of taking *all* that may be offered, to his surfeit, of matter indigestible.

THOS. A. FAWCETT.

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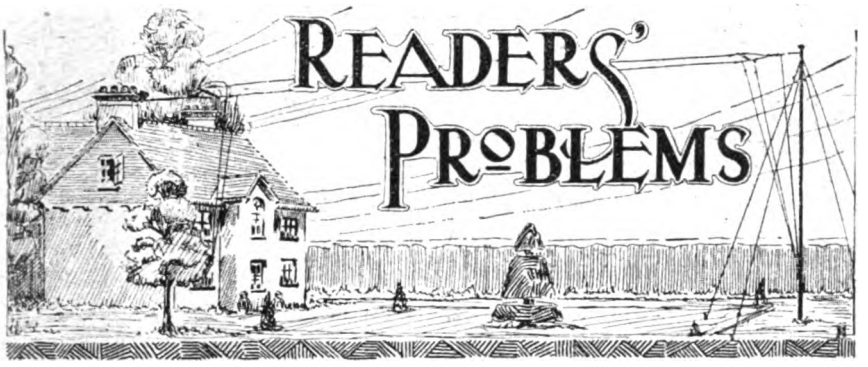

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Choosing Inductances.

I have a number of commercial plug-in inductances marked with their values in microhenrys, and propose to use them in the construction of a loosely coupled tuner for long-wave broadcasting only. What value would be necessary to cover the band with a 0.0005 mfd. tuning condenser? E. T.

A coil of about 2,000 microhenrys should be sufficient to enable you to reach the upper limit of the "official" long-wave broadcasting band, but by using a value of, say, 3,000 microhenrys the lower limit of your range would not be unduly high; in fact, anything between the two values we have given would be fairly satisfactory.

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For Headphone Reception.

My set, intended solely for headphone reception, comprises two high-amplification H.F. stages, followed by an anode bend detector. I have seen it stated that this form of detection is not the most suitable when telephones are connected directly in the anode circuit, but prefer this method, and should like to retain it. My main difficulty is that capacity effects are troublesome; when my hand approaches the aerial end of the set a certain amount of instability is produced. I take it that this trouble could be overcome by taking steps to restrict the circulation of H.F. currents through the phones, and should be obliged if you would give me a circuit diagram of a recommended arrangement for the detector. It should perhaps be added that the set is completely screened, with the exception of the aerial-grid coil. H. B.

It is not unusual to find that "end-to-end" feed-back through stray capacities is often responsible for trouble in a high-efficiency multi-stage H.F. amplifier such as that you describe, but there should be no great difficulty in overcoming the trouble. We suggest that the detector connections should be arranged as shown in Fig. 1. An H.F. choke is inserted directly in the detector anode circuit, and a by-pass condenser, C, is shunted between plate and filament. This condenser should be as large as you can conveniently make it without impairing the quality of reproduction, and in all probability a value of between 0.0005 and 0.001 mfd. will be suitable. It is safest

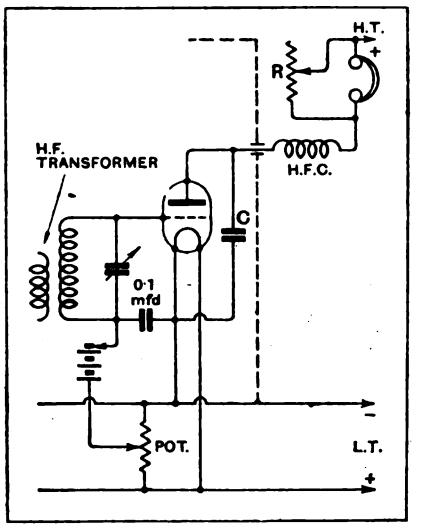

Fig. 1.—Bottom bend detector with phones in its anode circuit.

to mount the choke outside the screening box in the position shown, in order to avoid any risk of coupling between it and the detector grid coil—in this case the secondary of the H.F. transformer.

By connecting a volume control resistance, R, across the telephones, you will be able to operate the detector under the best conditions without producing excessively loud signals, and at the same time quality will be improved when the resistance is set at a comparatively low value.

We have shown, in addition to the detector grid bias battery, a potentiometer for fine regulation of voltage; this is a refinement that will seldom be really necessary with modern valves of the type used for anode bend detection, but it may be useful in a long-range set when receiving extremely weak signals.

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Remote Control.

Will you please refer me to a back number of "The Wireless World" giving instructions for making a relay (for remote control purposes) with the parts of an ordinary electric bell? N. P. R.

This conversion was described in an illustrated article in our issue of July 27th, 1927. Although the relay was for a somewhat specialised circuit arrangement, giving control both of volume and of filament switching, it would be equally suitable for ordinary purposes.

A word of warning: simple relays of this kind are apt to give trouble if they are called upon to interrupt a heavy current.

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Transportable Short-wave Set.

For use in West Africa, I am thinking of building a short-wave receiver in "transportable" form, complete with its batteries in a single containing case. An improvised "open" aerial will be used. On account of the climate, the current supply problem is a difficult one, particularly with regard to H.T., and I have decided to use the smallest number of inert dry cells that will give reasonable results. Can you give me an idea as to the lowest permissible H.T. voltage, and also say whether the general circuit arrangement of the original "Empire Receiver" or of the "New Empire Receiver" would be the most suitable for my particular purpose? T. C. A.

We suggest that the circuit of the original "Empire Receiver" described in *The Wireless World* of June 29th, 1927, would be the better of the two you mention. This set should give very fair results with an H.T. voltage of about 40 (25 to 30 dry cells).

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Parallel-feed Transformer Coupling.

Is there any reason why a volume control resistance should not be shunted across the primary winding of an L.F. transformer connected in a parallel-feed circuit? G. L. B.

This method of volume control is applicable to the "parallel" form of connection, and is applied in exactly the same manner as when the primary is connected in series with the valve anode.

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Modified Screening Box.

I am thinking of making up a set on the lines of "The Flat-Dwellers' A.C. Three" for use with an open aerial, but should like to use a copper screening box measuring approximately 8in. cube, which I already have. Do you think that this would be a satisfactory substitute for the completely screened case used for the set as originally described, and, if so, will you please give me a diagram showing which components should be included in the metal case? H. D. L.

It should be possible to construct a successful set on the lines you suggest, but the use of rather less complete screening than that included in the original will entail meticulous care in "decoupling" the various circuits.

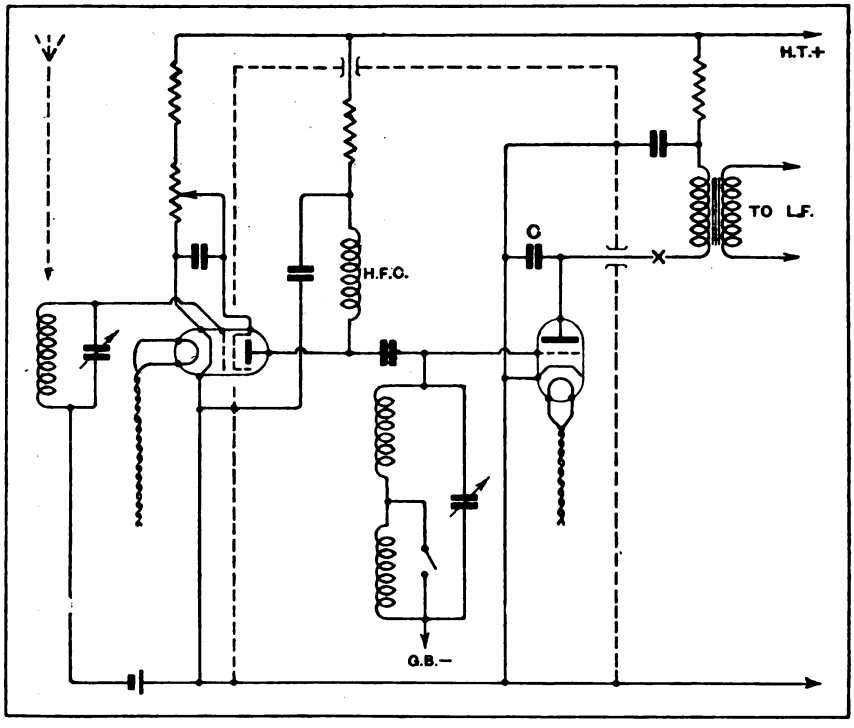

Fig. 2.—Parallel-feed H.F. amplifier, showing screened components.

The circuit diagram for which you ask is given in Fig. 2. In view of your proposed departure from the original layout we think it will probably be necessary to take more elaborate precautions with regard to the anode circuit of the detector, and it will be advisable to connect the detector anode by-pass condenser between plate and cathode of the valve, and very possibly to insert an H.F. choke in the position marked X. As an alternative to the use of a choke you could use a non-inductive resistance of two or three thousand ohms; a value of this order would not seriously reduce the amount of L.F. amplification obtainable.

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Waveband Switching or Interchangeable Coils?

I have seen it stated that a receiver is considerably more sensitive when interchangeable coils are used than when waveband switching is adopted, and am consequently in doubt as to whether it will be wise to proceed with my proposed scheme for fitting wave-change switches to my set. Will you please give me your opinion on the matter? J. B. S.

We think that the statement quoted by you is unduly strong. While it cannot be denied that switching induces some small loss, the falling-off in amplification is generally so small that it is difficult to measure, let alone to hear any reduction in signal strength due to it. But there is another aspect of the question not always appreciated; a set with plug-in coils built to a given standard of efficiency will tend to be rather more compact than when a switch change-over is included. This is for the reason that in the latter type of receiver space must be allowed for two sets of coils, and, as you are doubtless aware, the efficiency of a high-frequency inductance winding is dependent to a great extent on its physical dimensions.

H.F. Transformers, Tuned Anode, or Parallel Feed?

I am at a loss to know which is the best form of H.F. coupling for my projected set. A large-capacity H.T. accumulator is to be used, and so I take it that there is no reason why I should not avail myself of the simplicity of the tuned anode method; but will this give as much amplification as a properly designed transformer?

Again, there is the parallel-feed method with an H.F. choke in the plate circuit. Is it possible for a set including this arrangement to be as sensitive as when either of the other schemes are employed? S. L. W.

It is quite impossible adequately to compare the relative merits of these methods of coupling in a few words, but, speaking generally, it is true to say that tuned anode coupling can provide as much pure H.F. amplification as any other device, although, if the valve impedance is on the low side, it will be necessary to convert the coil to an auto-transformer by "tapping down" the plate connection.

The parallel-feed method cannot give as much amplification as either of the other methods, because the choke is in parallel with the tuned circuit, and consequently is responsible for a reduction in its dynamic resistance.

In making comparisons from the point of view of amplification efficiency, it must not be forgotten that the residual inter-electrode capacity of the valve must be taken into consideration, and in practice it generally makes little difference from this aspect alone whichever form of coupling is chosen, as it is generally possible to reach the limit of amplification with any one of them.

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More Magnification Wanted.

Taking into consideration the fact that I am compelled to use a very short indoor aerial, the performance of my "Everyman Four" is more than satisfactory, but there are occasions on which I should like to extend its range. Is there any simple method whereby its overall sensitivity may be greatly increased? C. D.

We fear it is inevitable that your range of reception should be somewhat limited when the set is operated with a very short aerial, and it is not possible to improve matters to an extent that is readily audible without making sweeping alterations. We assume, of course, that your H.F. valve is of an efficient modern type, and that your detector valve is both suitably chosen and correctly operated in the matter of grid bias and anode voltages.

We are inclined to make the more or less obvious suggestion that you should use as many as possible of your present parts for the construction of a "two-H.F." set; but before doing so you should try the effect of joining your aerial directly to the "grid" end of the aerial-grid transformer, and not to the normal aerial terminals. When a very short length of wire is used as a collector, this alteration often makes a very decided improvement in signal strength.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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AMATEUR STATUS.

AT a time when the United States of America is offering congratulations to its radio amateur organisations on the prosperity and strength of the movement a very different state of affairs prevails in this country and one which merits no congratulations.

We understand that at the present time there are just over nine hundred amateurs in Britain with transmitting permits. This figure shows a very definite reduction on former totals, for the number of amateurs licensed by the Post Office has stood as high as fifteen hundred only a short while back. The Post Office would no doubt say that the falling off in numbers is due to lack of interest on the part of the amateur, but we believe that whilst the interest and desire to participate in experimental transmission is still as keen as ever, the Post Office regulations have made it so difficult to conform to the conditions imposed on a licensee that the majority of amateurs are giving up their interest in disgust. We fail to see why the Post Office regulations in regard to the operation of amateur transmitting stations should be so exacting. If the amateurs were given a band within which to operate, then their own organisation would see to it that the individual amateurs would "play fair" amongst themselves, and, for the Post Office, it would be time enough to interfere when any amateur was detected working outside the band allocated for amateur use. The British amateur has always held a high reputation in the European ether.

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"OLD LAMPS FOR NEW."

SINCE the publication of correspondence under the above heading in *The Wireless World* we have received a large number of letters from readers expressing their satisfaction at the very generous attitude adopted by British valve manufacturers generally in the matter of replacements of faulty or doubtful valves. It is very pleasing to have this definite evidence of the advantage which the purchase of valves manufactured in this country offers, where the purchaser can get into direct touch with the actual manufacturer if any fault in construction should impair the life or the performance of the valve.

We do not think, however, that this attitude adopted by the manufacturer entirely disposes of the situation which prompted the correspondence already published on this subject. It will be remembered that the complaint was made that as valves were sold at present the purchaser had absolutely no guarantee that the valve had not already been in use, say, by the retailer, for demonstration purposes. Then along came another correspondent who admitted that he was able to borrow valves regularly from his local wireless dealer and return them after he had tried their performance in his experimental sets.

Sealed Valve Cartons.

We consider that it ought not to be possible for such a position to exist. It may be argued that no special precaution is taken in the case of electric lamps to prevent them from being used; but surely this is a rather different matter, since the valve is so much more fragile and much damage could be done to a valve without preventing the filament from lighting. It would seem very desirable that the valve manufacturers should devise some means of protecting the customer from the risk that the valve he purchases has been tampered with, and some special design of carton would easily give the necessary protection. Or the carton need merely be sealed in some suitable manner to prevent opening by anyone other than the purchaser.

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The TUNED GRID CIRCUIT

Parallel Choke Feed Circuit in H.F. Amplifiers.

By A. L. M. SOWERBY, M.Sc.

IN the majority of cases where a radio-choke is employed in a receiver it is used in the plate circuit of the detector valve, when its function is to deflect some of the radio-frequency component in the plate circuit through the reaction control circuit. Such an arrangement is shown in Fig. 1, which shows a single-valve receiver in which the choke is placed on point-duty in this manner.

Figures that have been given for typical commercial chokes in the section entitled "Laboratory Tests" show that the impedance offered by a choke, when shunted by the various stray capacities present in the circuit, amounts to something like ten to forty thousand ohms on the broadcast band, rising as the wavelength is increased to a maximum of perhaps 300,000 ohms at the frequency of resonance. It has been pointed out[1] that the low impedance offered by the choke to currents of the frequencies used for the broadcast band is not of moment when the choke is employed in the manner suggested in Fig. 1, for the reaction condenser also offers a low impedance at these frequencies, so that a current adequate for the provision of proper reaction effects flows through the coil and condenser shunted across the choke.

The tuned grid H.F. coupling has been rather neglected in receiver design. Is this method of H.F. amplification inferior in its results to the more usually adopted tuned anode or transformer? In this article the circuit conditions are carefully analysed and the merits of the arrangement explained.

Apart from this use, and from applications in high-frequency filter-circuits of various kinds, the radio-choke has also found employment in the coupling between successive stages of high-frequency amplification, or between the last of such stages and the detector valve. Sometimes the choke constitutes the whole of the coupling, as in Fig. 2, while in circuits on the lines of Fig. 3 it is supported by the presence of a tuned circuit. The present note is intended to emphasise the radical difference between these two apparently similar circuits, and to show the behaviour of a coupling in which both a choke and a tuned circuit are included.

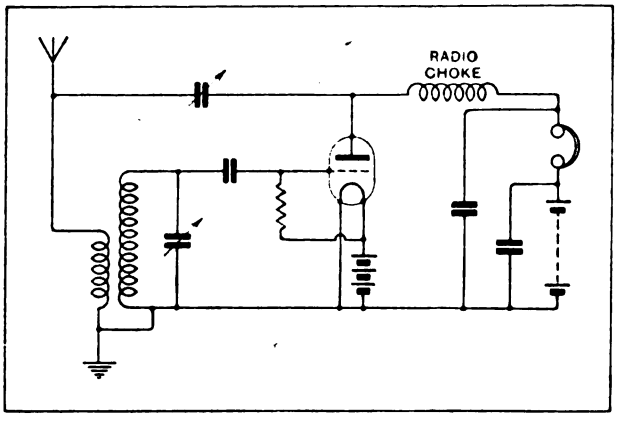

Fig. 1.—A single-valve receiver in which a radio-choke is employed to deflect high-frequency currents into the reaction circuit.

The amplification attained in a circuit such as that of Fig. 2 will be higher the higher the impedance of the components connected in the plate circuit of the valve. We must therefore have some idea of the impedance of a typical choke at various wavelengths before we can make any very confident statements about the degree of amplification to be expected from such an arrangement. The impedance curve of a typical choke is reproduced in Fig. 4, from which it will be seen at a glance that over the lower broadcast band of wavelengths from 200 to 600 metres the impedance is low. We can, therefore, state with perfect certainty that the amplification that can be extracted from the circuit of Fig. 2 is also low, being only a fraction of the amplification factor of the valve.

If we compare the circuit of Fig. 3 with that which we have just been discussing, we see that the only change is that now a tuned circuit replaces the grid leak.

Choke Coupling *v.* Tuned Grid.

Since there is no objection to using a grid leak of five megohms if we so desire, while the dynamic resistance of a tuned circuit can only with difficulty be raised as high as one-tenth of this value, it would appear reasonable to suppose that the total impedance between plate of V_1 and earth in Fig. 3 would be even lower still, and that the amplification of this arrangement would be even less than in the preceding case.

This mode of viewing the circuit is really based on the well-known fact that if two resistances are placed in parallel more current flows through the two than would flow through either alone, so that the combination has a lower resistance than either of its component parts. It is not safe, however, to apply these direct-current notions to alternating-current problems, and in the present instance the result of so doing has been to lead us to an utterly erroneous conclusion. A slightly more detailed examination of both circuits will bring to light the fallacy in our reasoning.

When the choke stands alone, as in Fig. 2, the

[1] "H.F. Chokes," *Wireless World*, Sept. 26th, 1928, page 372.

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The Tuned Grid Circuit.—

impedance in the anode circuit of the valve is simply that of the choke in parallel with a selection of stray capacities. The grid leak and coupling condenser, if their values are properly chosen, make so trifling a contribution to the total impedance between the anode of V_1 and earth that they may be neglected altogether. Remembering also that if the high-tension supply is shunted by by-pass condensers, as is usual, "H.T.+" will have the same high-frequency potential as the filament of the valve, Fig. 2 may be simplified down to the skeleton diagram of Fig. 5. In this simplified diagram the H.T. battery is omitted, and C and r have been inserted to represent respectively the total stray capacities and the high-frequency resistance of the radio-choke, the inductance of which is indicated by L.

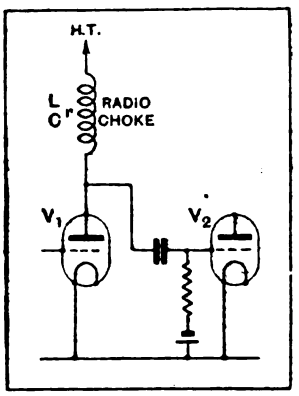

Fig. 2.—H.F. stage in which a radio-choke is the sole coupling between the valves. Compare Figs. 3 and 5.

The stray capacities, which include the stray capacity of the choke itself, amount altogether to a very respectable number of micromicrofarads—perhaps 20 to 25—while the inductance of the choke is usually in the neighbourhood of one or two hundred millihenrys. Since the resonant frequency of an average choke, even outside the set, is found to correspond with a wavelength of two or three thousand metres, one might expect that on the broadcast band it would behave chiefly as a condenser.

Low Impedance of Choke Coupling

If we now consider the impedance value to 300-metre signals of the capacity suggested as typical we obtain a figure of 7,000 ohms, while the impedance offered by the inductance is nearly a megohm. Clearly, practically the whole of the high-frequency plate-current of the valve will flow through the stray capacity, and the inductance will play practically no part in determining the behaviour of the circuit at wavelengths within the lower broadcast band. From the high-frequency point of view we may therefore ignore the L, r branch in Fig. 5, and consider the plate circuit as containing only the capacity C.

It is not necessary, for our present purpose, to go into the figures for amplification that will be obtained for such a circuit. It is enough to point out that 7,000 ohms is far too low an impedance to provide amplification anywhere approaching that obtainable from even the worst tuned stage, and to bear very carefully in mind the fact that on the broadcast wave-band the choke behaves exactly as though it were a small condenser.

Following the same method that we have already used in analysing the circuit of Fig. 2, we can reduce that of Fig. 3 to the scheme shown in Fig. 6. This, as might be expected, is simply Fig. 5 with the tuning coil of inductance L_1 and resistance r_1, and the tuning condenser C_1 connected in parallel with the choke. The full analysis of the behaviour of such a circuit would lead to mathematical complications of the most alarming description, without yielding, so far as one can see, the smallest scrap of useful information. We will, therefore, content ourselves with a commonsense qualitative discussion of it, which will be equally useful, and will be very much less like hard work.

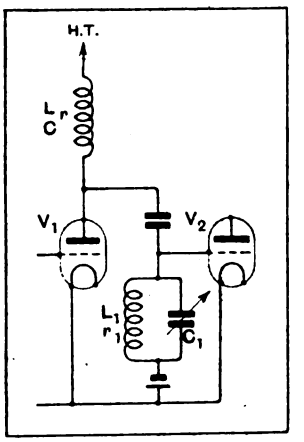

Fig. 3.—Circuit differing from Fig. 2 in that a tuned circuit, of dynamic resistance perhaps of 0.25 megohm, replaces a grid leak. Nevertheless, the total impedance between plate of V_1 and filament is greater, not less.

In the first place, we have already seen, while investigating Fig. 5, that the branch L, r, representing the inductance and resistance of the choke, amounts to an impedance of about a megohm. In comparison with the much lower impedance of C, the stray capacities, we can therefore proceed to forget this branch completely. Imagining it removed, we are left with nothing but the stray capacities C of which the stray capacity of the choke itself is but a small part, in parallel with a perfectly ordinary tuned circuit of the familiar "tuned anode" type. These stray capacities will have no other effect on the tuned circuit than that of compelling us to use a lower setting of the tuning

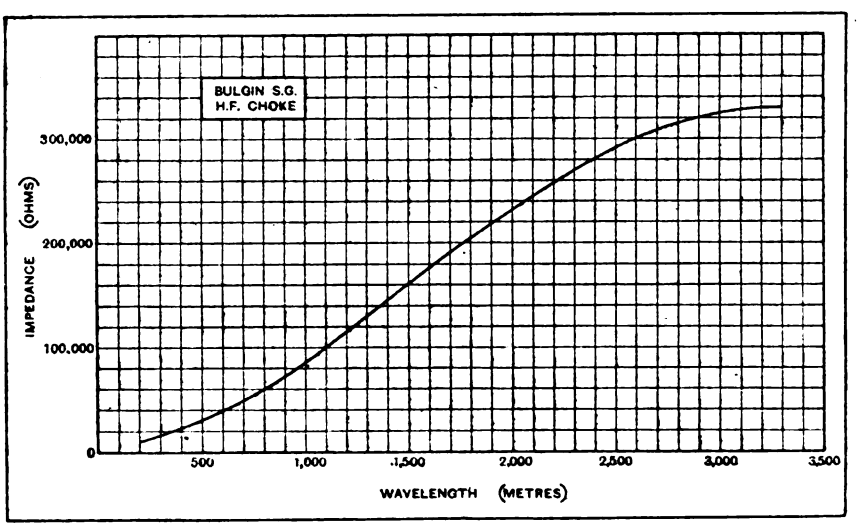

Fig. 4.—Impedance curve of H.F. choke (Bulgin). External capacity, 8 micromicrofarads.

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The Tuned Grid Circuit.—

condenser C_1 than would have been required, for the same wavelength, if they had been absent, for the total tuning capacity in the circuit is made up of C_1 and C in parallel. The whole complex circuit lying between the points X, X is thus equivalent to a simple tuned circuit of the most everyday kind, so that we may regard the circuit of Fig. 3 as being nothing more than a variant of the simple tuned anode arrangement.

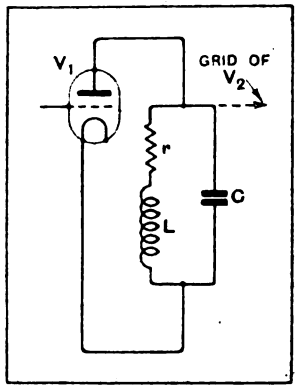

Fig. 5.—Simplified "skeleton" diagram of the circuit of Fig. 2. C represents the total of stray capacities in the plate circuit of V_1.

The fallacy in the argument that by putting a tuned circuit in parallel with the choke the maximum total impedance could not be made to exceed that of the choke alone now stands revealed. Any tuned circuit consists of two impedances (coil and condenser), both quite low in value, but opposite in sign. At the wavelength to which the circuit is tuned, they are in addition equal in magnitude, so that their effects cancel out almost completely, leaving a high impedance for the combination of the two. The choke, when used alone on the broadcast band, provides, as we have seen, only one of these impedances; by the addition of the other (the inductance L_1) this can be cancelled out for any one wavelength, while the introduction of the condenser C_1 provides the finishing touch by making it possible to obtain the balance at any frequency within the tuning range.

Losses Arising in the Choke.

Although the introduction of the choke does not affect the *general* behaviour of the tuned circuit, we must not too hastily jump to the conclusion that the tuned circuit of Fig. 3 is completely unaffected by its presence. If the inductance of the choke were infinitely high, its resistance zero, and its stray capacity entirely free from losses, this would indeed be the case. The fact that none of these impossible conditions is fulfilled in any choke results, like any other deviation from perfection, in increasing the effective resistance r_1 of the tuned circuit L_1C_1, and so flattening the tuning a little and decreasing slightly the amplification attainable.

The magnitude of the resistance introduced by the choke is not very great, though it is enough to diminish quite perceptibly the performance of a receiver in which all other losses have been kept to the lowest possible value. Measurements that the writer has made at various times indicate that the best of the commercial chokes are equivalent on the lower broadcast band to resistances of the order of one megohm connected in parallel with the tuned circuit. This figure, however, is subject to quite wide variations, the lowest and highest of which records are to hand being respectively 350,000 ohms and 4 megohms for the same choke on different but neighbouring wavelengths.

"Back-coupling" Avoided.

It is at least safe to conclude that the circuit of Fig. 3 will give a little less amplification than the corresponding tuned anode circuit, so that when it is desired to extract the utmost amplification from a screen-grid valve the simple tuned anode is preferable. As this is inclined to lead to difficulties unless high-tension accumulators are used to supply the anode current, one is generally compelled to employ either a high-frequency transformer or choke-feed, as in Fig. 3, either of which will help towards "de-coupling" the

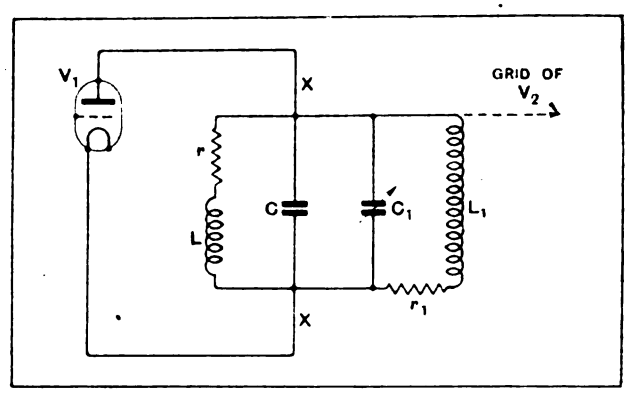

Fig. 6.—Skeleton diagram of the circuit of Fig. 3. The connection between the two can be traced by the lettering, which is arranged to correspond.

various anode circuits of the receiver, and both of which tend to lessen amplification a little.

Whether choke-feed or transformer coupling is the better alternative it is at present hard to say, but there can at least be no doubt that the use of a radio-choke in this connection is a matter which calls for more detailed investigation than it has yet received.

A.C. SCREEN-GRID VALVES.

MAINS operated valves mounted on standard bases but with the addition of a fifth centre pin were described in a recent issue. Apart from the convenience derived by the substitution of mains in place of the L.T. accumulator, other important advantages are worthy of attention. Owing to the absence of a potential drop such as exists across the filament of the battery operated valve, the electron stream becomes less restricted. This effect is, of course, due to the absence of a magnetic field near the emitting surface. In consequence greatly improved characteristics are possessed by the new screen-grid indirectly heated valves apart from those advantages due to a more generous source of current supply.

Readers will have already appreciated the enormous H.F. stage amplification which can be obtained from the A.C./S valve, and it is therefore interesting to note that there is shortly to appear on the market an extensive series of A.C. screen-grid valves having amplification factors from 400 to 1,000 combined with high impedance. With such characteristics it is possible to attain a stage amplification of over 200. H.F. amplification should now enter upon a new era of prosperity.

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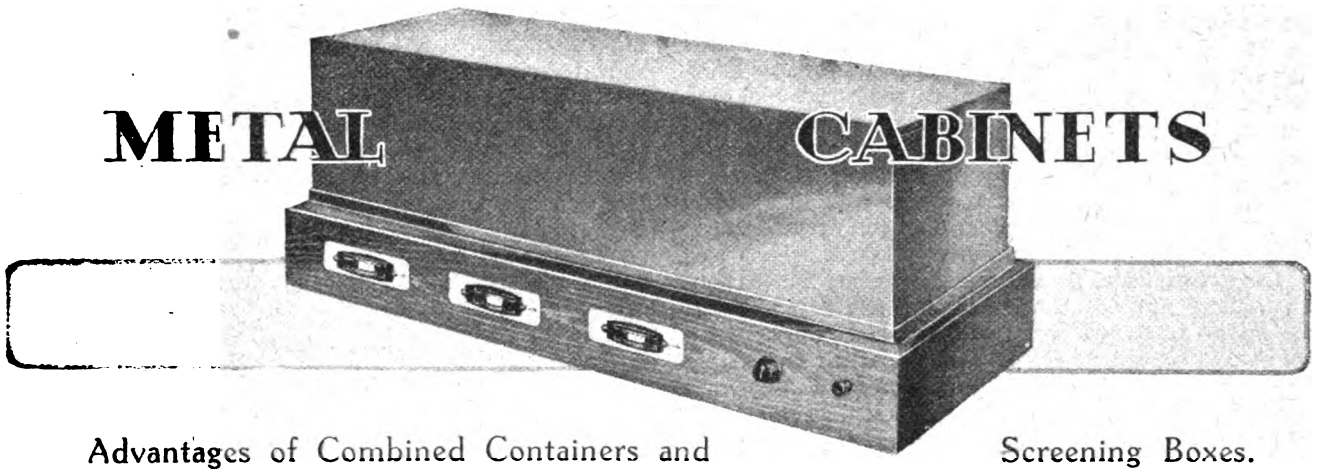
METAL CABINETS



Advantages of Combined Containers and Screening Boxes.

RECEIVERS with screen-grid H.F. amplifying valves call for more extensive screening than those in which neutralised triodes are used. This is one of those sweeping generalities that are so dangerous when applied to technical wireless matters, but in this case, and speaking from a strictly practical point of view, the statement may be allowed to stand without qualifications. Every serious wireless worker, after having made initial tests of his first eagerly awaited S.G. valves, must have come to the conclusion that, in order to get an amplification equal to, not to say in excess of, that afforded by ordinary triodes with good interstage couplings and comparatively simple screening, it was essential to take meticulous care to minimise interaction between circuits.

If our experimenter was in any way concerned with the design of sets for home construction, his findings in this matter probably gave rise to some regrets, as the need for elaborate screening obviously tended to offset the advantages of the new valve in the way of its capability to provide good amplification with small, simple and inexpensive coils. There can be no question that screened sets on more or less conventional lines are none too easy to build, as compared with their comparatively simple prototypes of a few years ago; not only does the average amateur find that metal is a difficult material in which to work, but he also learns that components inside a screening box are always more or less inaccessible, and consequently difficult to wire.

Five Hundred Times Amplification.

This trouble of inaccessibility can be overcome by making the box in sections, and so arranging matters that the sides and back are secured in position after all, or at any rate most, of the wiring is done. But again we come up against a drawback: present-day practice inclines always towards higher and higher amplification—both per stage and overall—and in a highly efficient amplifier screening is often found to be inadequate unless all joints are well and truly "closed" in such a way that an electrical seal is formed. This condition can hardly be realised if the box is built up of sheets bolted together, although a fairly satisfactory screen of this kind can be devised for a single H.F. stage of which the amplification does not exceed some 50 or 60 times, provided some care is taken in the disposition of components.

It seems probable that in the near future we shall expect—and get—an amplification of something like 500 times from a single stage, helped, of course, by neutralisation and the use of the most modern high-efficiency valves. Preliminary experiments with this kind of high-frequency amplifier would indicate the need for mounting the valve in such a way that it is not affected by the field of the coils, and in any case this precaution must almost always be observed when building a two-stage amplifier designed for a reasonably high degree of sensitivity. Consequently, it becomes necessary to devise some form of "outboard" mounting, which tends considerably to increase the bulk of the set and also to mar its workmanlike appearance.

The Demand for Better Screening Boxes.

But enough of this jeremiad; let us close our tale of woe on the economic note. A three-compartment screening box, to be more or less self-supporting and capable of performing its functions in a "high-gain" set, must of necessity be fairly rigidly built, and in consequence will not be cheap. Adopting a conventional method of construction, we find that the majority of the surface area of the insulating panel will be completely wasted, and that a large and comparatively costly cabinet will be necessary to house the whole set, of which the bulk has perhaps been increased by excrescences in the form of projecting valves.

The remedy for all this seems to be fairly obvious: What is needed is an inexpensive all-metal, or a wood-and-metal case combining the functions of screen and container. It should be designed to give reasonably good access to the components, must be efficient electrically, and should be at least sufficiently inoffensive to the eye to merit a place in a living room, even if it cannot hope for the *entrée* into more formal surroundings. Those whose wireless sets must look like something other than what they are may be satisfied by the addition of ornamental woodwork camouflage, at, of course, an increased price.

As far as the present writer is aware, thought has not been extensively devoted to the design of containers to

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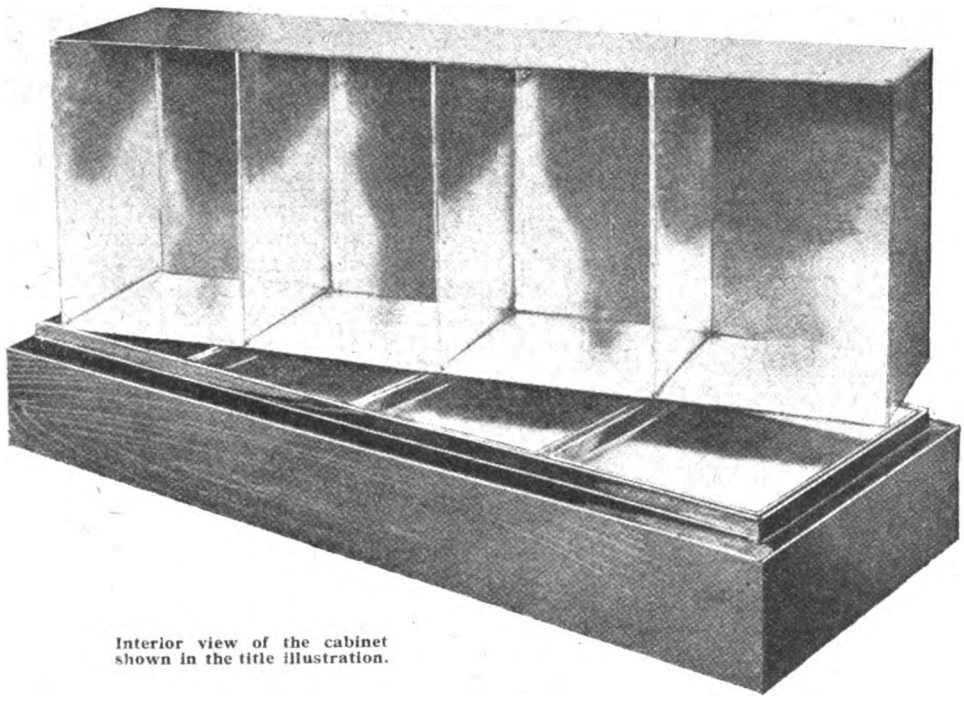
Metal Cabinets.—

comply with these requirements, although the matter has had the attention of the technical staff of *The Wireless World*, to whom the present-day constructional difficulties in the way of the set builder are a matter of very real concern. It is probably easier than ever it was to make a good set, judged by ordinary standards; only when we come to consider receivers with outstanding performance as distance-getters does the necessity arise for exceptional care in screening.

The experimental metal cabinets of which illustrations accompany this article were intended to accommodate (1) a four- or five-valve set with two H.F. stages; (2) a four-valve set with a single highly efficient H.F. stage and a separately-tuned aerial circuit; or (3) a three-valve A.C. mains set with a similar aerial tuner, its H.T. eliminator, and with a single neutralised H.F. stage giving the maximum possible amplification. The first container, shown on the next page, had four separate compartments in its upper section, while the base (extended to give stability and weight) was open, and was intended to accommodate H.F. valves, all low-tension wiring, and such components that do not need special screening. Its upper section was divided diagonally, and the part forming a lid was hinged along its lower rear edge. This form of construction gave good accessibility; anticipating unfavourable criticism of the appearance, it should be said that it was improved in this respect by replacing the engine-turned finish by a coating of matt-surface enamel. Even with this improvement the cabinet did not prove a success; it was by no means cheap to build, and it was a difficult mechanical problem to arrange a good electrical contact along the diagonal edges of the transverse partitions, while the mounting of components involved the drilling of a number of holes (some in awkward positions) through the metal base and partitions.



Interior view of the cabinet shown in the title illustration.

This design was finally abandoned in favour of that shown in the remaining illustration, and at the head of this article. The base is a shallow box of oak, ⅜in. thick, open at the bottom, and with a top of ¼in. plywood, over which is placed a sheet of metal carrying separate trays for each compartment. Strips of metal bent at right angles are soldered to the metal sheet so as to form channels round the edges of the trays; into these channels are inserted the edges of the metal cover and also of its partitions.

Preventing Circuit Interaction.

There are several methods of ensuring a good electrical seal at the junctions between cover and base. It is possible to turn over the lower edges of the former, making saw cuts at frequent intervals so as to increase the natural springiness of the metal, or to adopt a similar procedure with respect to the edges of the trays and angle pieces. Alternatively, strips of braided metal tape, preferably bent to a U-section, may be laid along each of the channels, to serve as a form of flexible gasket.

Tinned sheet steel was used in the construction of the cabinet illustrated, and there seems to be no valid reason why this cheap and convenient material should not serve the purpose, provided that steps are taken to allow reasonable spacing between inductance coils and metal work.

It is intended that the removable cover should be entirely free from components, all apparatus requiring thorough screening being mounted on the upper trays, while other gear is secured either to the inner surfaces of the wooden plinth or to the lower surface of its plywood top. As in the case of the earlier cabinet, screen-grid high-frequency valves are also housed in this space, which will also accommodate a number of subsidiary parts for which room cannot be conveniently found in the screening boxes.

All controls are fitted to the front panel of the plinth base, and here we come to the one disadvantage of the scheme; as a matter of fact, this disadvantage is probably more apparent than real, and most of the seeming difficulties disappear if conventional methods are abandoned. Tuning condensers are fitted with their spindles vertical and passing through the metal trays and plywood sub-base: unfortunately standard dials are unsuitable, but edgewise dials of large diameter can

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Metal Cabinets.—be used, and will provide more than sufficiently accurate control for any tuning circuit likely to form part of a modern set.

Waveband switches present another minor problem which is easily solved; these components can be fitted with their levers projecting through the bottom of the screening compartment so that they can be controlled by a push rod. Where several switches are used, their levers are coupled to a single long rod terminating in a knob projecting through the side of the plinth.

A neutralising condenser is secured in a similar manner, but, frequent adjustment not being required, it is sufficient if access to the knob can be obtained by tilting the entire receiver backwards.

A screen-grid valve itself provides an interstage connection, but where neutralised couplings are used, and for any "danger" leads between compartments, it is convenient to make one or two small tunnels for wiring by cutting a slot through the sides of the trays, at the same time making a corresponding depression in the edge of the cover.

Manufacturers' Help Needed.

There is a wide scope for finishing the large exposed metal surface: this detail can safely be left to those interested, and it will be enough to say that a set built on the lines suggested can be both neat and workmanlike; having decided upon the general principles of construction, it should not be a difficult matter to improve the appearance of the cabinet.

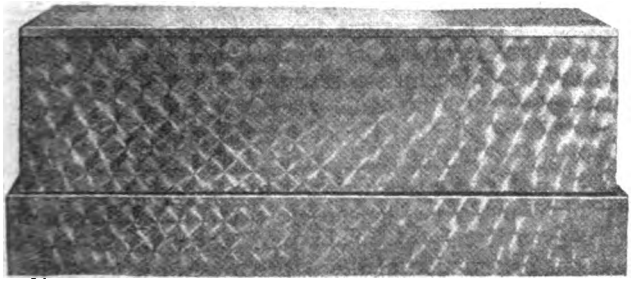
The metal cover and base shown are well within the capabilities of a tinsmith, and, complete with a suitable wooden base, should compare more than favourably in cost with the conventional cabinet, panel, screening boxes, and baseboard which they displace.

As already indicated, a cabinet as shown should have a wide range of application in the building of sensitive and comparatively ambitious receivers; in order that its usefulness may not be restricted, it is suggested that the inside dimensions of each of the four compartments should not be appreciably less than 7in. wide, 7in. high, and 9 or 10in. deep. The space inside the base should have a height of 3¼in.

It is realised that the construction of a screened container of this kind is hardly within the scope of the average amateur, but it is reasonable to hope that manufacturers will turn their attention to the commercial production of something on the lines suggested—modified, perhaps, to fall in with their own methods. Made in fair quantities, the price should be well below that charged by a sheet metal-working firm for making a single specimen to order. If suitable drum dials also become available, our remaining difficulty should disappear.

A three-compartment container of the same design.

While these cases are, as already stated, of greatest value for accommodating the highly sensitive type of receiver, it must not be thought that they are without their uses when simpler sets are in question. For a three-valve "H.F." set of fairly conventional design a container with overall dimensions (excluding base) of some 18 to 20in. wide, 7in. high, and 8in. deep should prove suitable; the H.F. stage could easily be made sufficiently "good" to enable the constructor to obtain practically the theoretical maximum obtainable magnification, which is seldom approached when conventional methods of screening are adopted. This cabinet would be divided into two compartments, that at the input end of the set measuring some 7in. in width. An intermediate size, with three separate compartments, would also be useful; one or other of these suggested cases should be adaptable for any of the high-efficiency sets made possible by improved valve designs.



An all-metal cabinet with diagonally divided internal screens.

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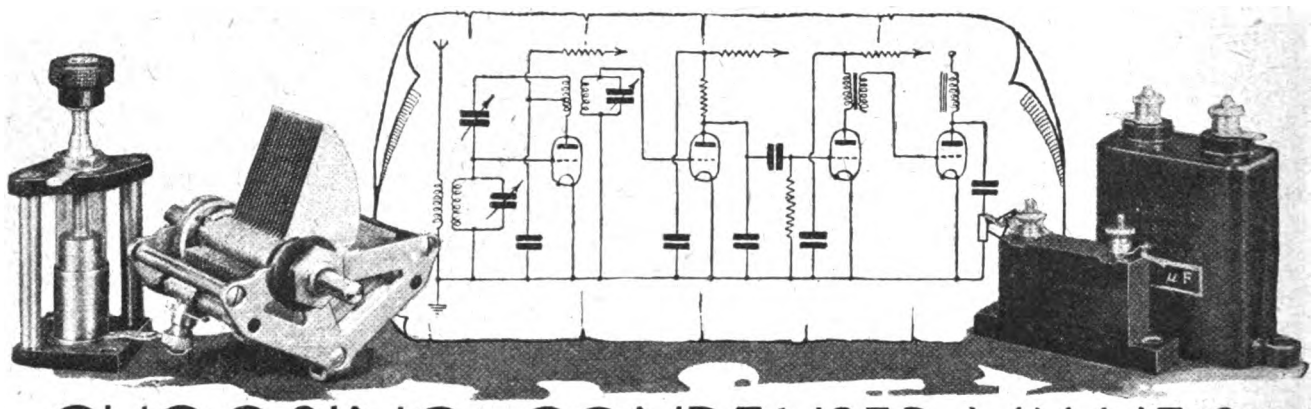

CHOOSING CONDENSER VALUES

How Incorrect Values Adversely Affect Receiver Performance.

By N. P. VINCER-MINTER.

IN a wireless set there are usually a considerable number of condensers, all of which have certain vital duties to perform. In no case, however, can one assign a definite value, except, perhaps, for the grid condenser of a leaky grid detector, which on the broadcast wavelength is usually specified as 0.0003 mfd. and advisedly so. If one takes an average set, which is probably a four-valve instrument consisting of one H.F. stage, be it triode or tetrode, detector, one R.C. stage, and one transformer-coupled stage, the total number of condensers used will average almost a dozen in number.

The first of these is the one usually placed in the aerial-lead in. The value usually assigned to this, if one be used, is 0.0001 mfd., although this is purely an arbitrary value. Using this value, one loses quite an appreciable amount of signal strength on long wavelengths in return for the selectivity gained, and it is advantageous to use in this position one of the small solid-dielectric variable condensers now on the market for this purpose. No losses need be feared as the result of the solid-dielectric, since the aerial circuit will in any case possess considerable damping.

0.00025 or 0.0005 ?

The condenser C_2 (Fig. 1) used for tuning the grid circuit of the H.F. valve should have a maximum value of 0.0005 mfd. for best all-round results on the normal broadcasting wavelengths. When choosing a condenser for this position it is imperative to choose one having as low a minimum as possible. If rather more voltage build-up is desired, together with a rather less crowded tuning scale, a 0.00025 mfd., 0.0003 mfd., or a 0.00035 mfd. condenser should be used. It must be remembered that in such a case selectivity will be rather less, and the frequency range covered by the tuning circuit will be curtailed.

C_1, which serves to by-pass energy across the grid battery, should be sufficiently large to by-pass all H.F. ... direct to filament negative. In other words, its reactance to the lowest radio frequencies with which the set is designed to deal must be very low. A 0.1 mfd. condenser is fully large enough here, but if the home constructor happens to have a spare condenser of larger value " by him " it may be used. If the set is properly laid out and the grid cell mounted so that all leads are as short as possible, it may have a lower value, such as 0.01 mfd., but it is inadvisable to attempt to dispense with it altogether in the case of a modern receiver, even if only one H.F. stage is used.

A Wasted Condenser.

Now matters are quite different when we come to the question of condenser C_{13} (Fig. 2). This is only shown in the circuit because so many people insert one in this position, thus wasting a condenser which could serve a useful purpose elsewhere. It will be realised that in this position the condenser is merely acting as a by-pass to a certain portion of the potentiometer which shunts the detector valve filament. Now we are not considering the case of a grid return lead which passes to the same grid battery as do similar connections from other valves, in which case it might be necessary to " decouple " all grid bias leads. Here we are merely considering a straightforward resistance which to all intents and purposes is non-inductive and which is associated with the grid circuit of one valve only. C_{13}, therefore, is totally unnecessary.

The value of C_8 is of very great importance, and on it hangs to a large extent the ultimate quality given at the output terminals of the receiver. The value of this condenser depends from the quality point of view upon, *inter alia*, the A.C. resistance of the detector valve. If we adopted the custom so rampant in 1926 of using a valve of very high A.C. resistance and amplification factor, as detector in conjunction with a very high anode resistance, the presence of this condenser even if only of 0.0001 mfd. value would result in serious attenuation of the upper musical frequencies, which itself gives rise to dull and lifeless reproduction in

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Choosing Condenser Values.—

general, coupled with "woolliness" in speech.

In this circuit the H.F. choke is supposed to deflect most of the H.F. energy in the plate circuit via C_8, whilst R_3 deflects the L.F. energy via C_7. Now if C_8 (which at any given frequency acts as a resistance, the rule being the higher the frequency, the lower the effective resistance) is comparable in resistance value at the upper end of the musical scale to the complicated network formed by R_3, C_7 and R_6, then obviously many of the upper musical frequencies are by-passed by C_8 and never reach the L.F. amplifier. It will probably be clearer if we ignore the H.F. choke and simply consider what we will call the R_3 network and C_8 as being two resistances in parallel at a certain given frequency. It will be obvious that the energy at any given frequency in the plate circuit of the detector valve will divide itself equally in proportion to these resistances; as we want as much of the energy associated with the upper speech frequencies as possible to take the alternative path, it behoves us to keep the resistance of C_8 at any given frequency as high as possible. This means that the *capacity* of C_8 must be kept as low as possible.

Now, it will occur to us that if we cannot, for other reasons, use too low a capacity (i.e., too high an effective resistance) at C_8 we can accomplish the same thing by lowering the resistance of the alternative path. This is precisely what we actually do in practice, and it will be found that if the value of the anode resistance R_3 is not greater than 250,000 ohms, a value of 0.0001 mfd. is permissible at C_8, although it will be far better to use only 100,000 ohms at R_3, which from our preceding arguments we know now to give the same beneficial effect in quality as if C_8 had been made of much smaller capacity. It may well be asked at this juncture, why not dispense with C_8 altogether? What useful purpose does it serve? This exact functioning of C_8 is far too vast a subject to be dwelt upon here, and must be left to a later date. Suffice to say that if C_8 is too small the detrimental effect on signal strength will be serious. If we are out for signal strength regardless of quality it will pay us to increase the value of C_8 to 0.0005 mfd. on the normal broadcasting wavelength, although a higher value than this will result in no further improvements except on longer wavelengths.

Coupling Condenser Complications.

With regard to condenser C_7 the value of this depends on the value of R_6. We have neither time nor space to dwell on the factors which determine the value of R_6 itself, but it is quite easy from our arguments in connection with C_8 to indicate in what manner C_7 and R_6 are interdependent. It is necessary to consider C_7 as being merely a resistance in series with R_6. We thus have two resistances in series. Care is taken to so arrange the value of C_7 that at the lowest musical frequency with which it is intended to deal, its resistance is small compared to that of R_6. Now, small resistance means large capacity, and it would seem, therefore, as though it were best to use as large a condenser as possible at C_7. Actually, the electrical size or capacity of C_7 is limited by the fact that it will unavoidably become charged up occasionally by a strong atmospheric or signal, and if it is too large it will not become discharged before the next impulse comes along.

It will be seen, therefore, that although we are in this case dealing with resistances in series our argu-

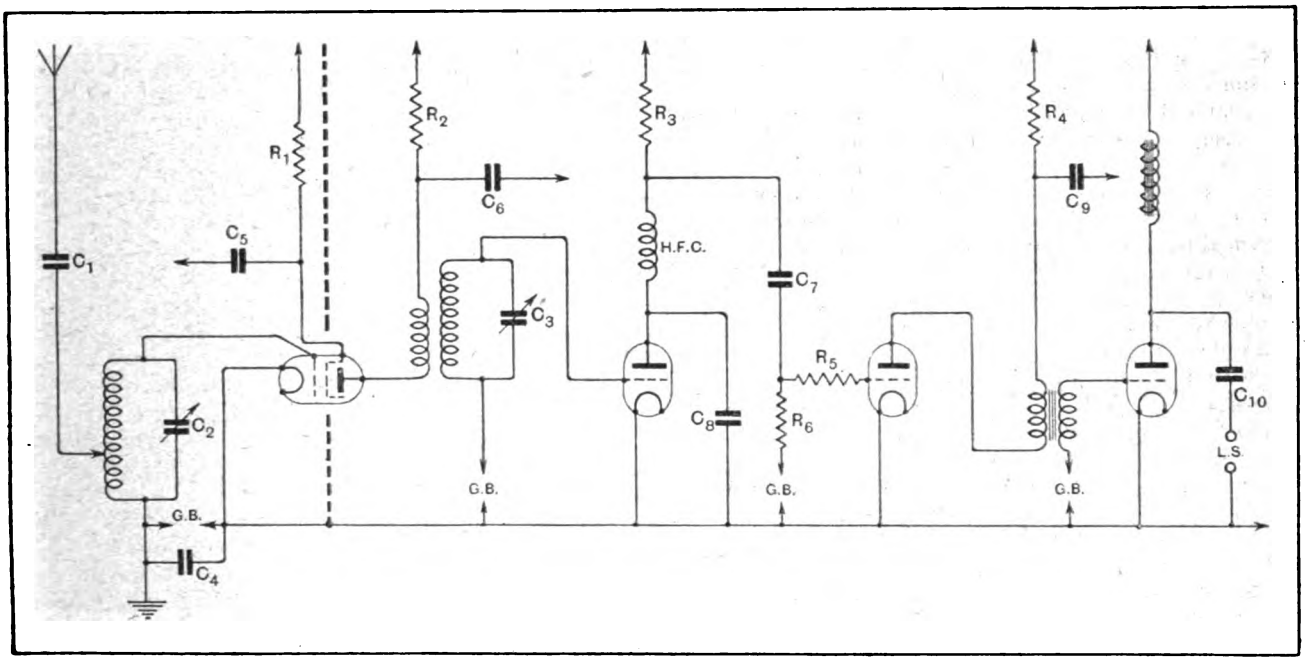

Fig. 1.—A modern four-valve set with decoupling arrangements.

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Choosing Condenser Values.—

ments in the case of C_8, where we were dealing with resistances in parallel, have greatly helped us. In practice, if a value of 2 or 3 megohms is used at R_6, C_7 should be about 0.01 mfd. in value in order to preserve the correct relationship between R_6 and C_7, and these values are the most commonly used. Many people, however, prefer to use 0.1 mfd. and 0.5 mfd., although they gain nothing thereby, assuming the grid-leak resistance is of the value given here.

With regard to C_{10} it is said by some schools of thought that it is only necessary that its value be such that it offers a very low impedance to the lowest note to be reproduced in comparison with the impedance offered by the loud speaker, and so a value of 4 mfd. or 6 mfd. is usually assigned to it. In practice, however, owing to the importance of correctly reproducing transients in order to give pleasing overall reproduction to the ear (which, after all, is the thing we are trying to please) a 2 mfd. condenser is usually to be preferred.

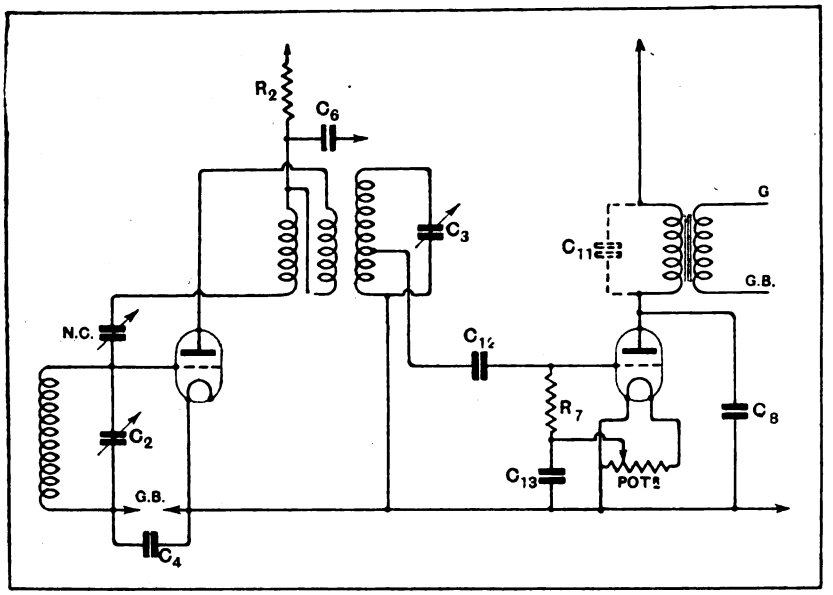

Fig. 2.—The same circuit as in Fig. 1, employing a neutralised triode H.F. amplifier and a leaky grid detector.

Importance of By-pass Condenser.

If we substitute a neutralised triode in place of an S.G. valve and use a leaky grid detector in place of anode bend, as in Fig. 2, no change will result in any condenser value except that of C_8, while the neutralising condenser, the grid condenser, and the condenser shown in dotted lines at C_{11} are newcomers. The neutralising condenser can be speedily dismissed from our minds as experience has taught us that it should have a maximum capacity of about 40 micro-microfarads, and be fairly accurately adjustable. The grid condenser has been referred to earlier in this article, and so it only remains to discuss C_8.

Now, in the first place, it should be said that there are some transformers on the market which have built into them a fixed condenser of 0.0003 mfd., which is connected in shunt with the primary. The instrument has in many cases a highly beneficial effect on the lower musical frequencies, and in such cases C_8 should be left out, and a decoupling condenser and resistance used in the plate circuit of the valve between the transformer primary and the H.T.+ connection to prevent A.C. entering the H.T. battery. This should not be taken to mean that such an arrangement is not desirable when the transformer has no built-in condenser. If the transformer is of a type not incorporating one of these instruments, it becomes highly desirable to use a condenser at C_8. Its value depends on the inductance and self-capacity of the primary. It is very unsafe to dogmatise on the value of any condenser used in this position, fully as dangerous, in fact, as it is to do so on the value of the grid condenser, and one can only say that, as a result of much experimental work, if a condenser of 0.0003 mfd. to 0.0005 mfd. is chosen it will be found to be a very effective compromise.

"Decoupling" Condensers.

With regard to condensers C_5, C_6 and C_9, these are, of course, part of the decoupling arrangements, and not concerned with the set proper. It is quite beyond the scope of this article to enter into the question of the values of these, except to state, in a purely arbitrary manner, that in the majority of cases a value of 2 mfd. is ample. The reader who has had the patience to read thus far, however, will readily grasp the fact that again we have to consider two resistances in parallel, as in the original case of C_8 and the network associated with R_5. It is solely a question of keeping the resistance due to the condenser at very low frequencies, small compared with the decoupling resistance, which, of course, is virtually in parallel with it.

The fact that values of 20,000 ohms and 2 mfd. are usually given for these two components respectively, will however, have undoubtedly been observed by readers. It is simple to find out the resistance of any condenser at any given frequency by using the well-worn condenser reactance formula. At fifty cycles, for instance, we find that the condenser is equal to a resistance of approximately 1,600 ohms. We thus have two paralleled paths for our fifty-cycle energy, one of 20,000 ohms and one of 1,600 ohms, and this energy will divide itself in inverse proportion to these resistances. It is now clear that a relatively small proportion of the A.C. energy passes through the H.T. battery or other source of H.T. supply. It will be arithmetically obvious that at higher frequencies the proportion is much smaller, so much so that in H.F. circuits where we are dealing with very high frequencies indeed, there is no need to use an anode feed resistance greater than 600 ohms. No harm, but rather a benefit, will result by using condensers larger than necessary, but using a high value of feed resistance will cause the dropping of vital volts.

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The "Breaking Up" of LOUD SPEAKER DIAPHRAGMS

An Analysis of the Modes of Vibration of the Diaphragm.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

WHEN the coil-drive loud speaker arrived there was much talk about "piston-action." The diaphragm, freely mounted at its periphery and driven by a member without constraint, was likened to a piston, the whole contraption moving bodily to and fro in a cylinder, so to speak. Such notions are

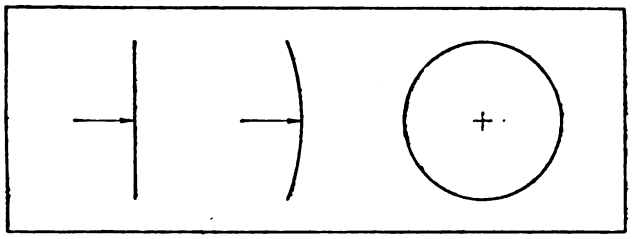

Fig. 1.—The bending of a disc of paper when acted on by a force at its centre.

very nice when endeavouring to explain matters in an elementary way, but the precise state of affairs is vastly different. Doubtless this pristine belief in piston action has led many people astray, and it is about time the illusion was shattered. For those who have studied Chapters IV and VIII in "Loud Speakers" the illusion probably never existed.

Let us take some simple examples by way of initiation into the mystery. A conical diaphragm is made from a thin sheet of paper. Imagine we have the original circular disc before the sectorial portion is removed to form a cone. Mount the circle on a compass

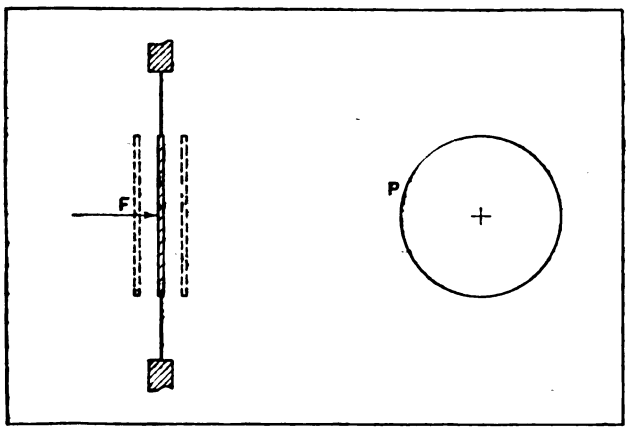

Fig. 2.—Showing steel disc freely mounted and acted upon by an axial force F. The dotted rectangles indicate the positions corresponding to A and B of Fig. 3.

needle as shown in Fig. 1—it may be mounted mentally with good results—and move the compass to and fro axially. The circle bends at its edge, and is loth to follow the motion of the centre. When the centre is pushed forward the edge follows reluctantly after a while. In other words, the disc does not move bodily, and there is a time interval between the central push and the peripheral motion corresponding thereto. If, on the other hand, the disc had been steel or brass, the peripheral motion would have appeared to occur at the same time as the central push, i.e., there would have been no lag visible to the naked eye.

The steel disc is very rigid, whereas the paper disc is very flabby. It is the much greater rigidity or degree of consolidation which enables the steel disc to move bodily, i.e., as a whole. To attain a certain degree

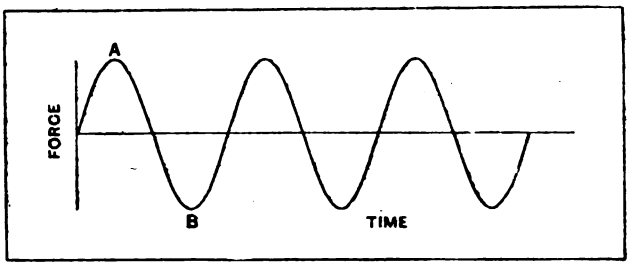

Fig. 3.—Illustrating the axial force F at any time. It is a sine wave force.

of rigidity the circular disc is transformed into a cone. When this is moved to and fro with the compass we cannot see any lag of the outer edge behind the centre. But the naked eye is easily deceived, because there is a definite lag which can be demonstrated optically in a simple manner, which will be described later.

Lag Between Centre and Periphery.

Coming back to the case of the steel disc, assume this to be freely mounted as illustrated in Fig. 2, and that we can apply an axial force to it when desired. Let the axial force be due to an alternating current passing through a coil situated in a strong magnetic field. The force is to be applied at the centre and not to a ring, as is customary in the coil-drive loud speaker. This is, of course, merely a matter of mechanical design. The relationship between force and time is illustrated in Fig. 3. When the central force F commences to act at A it is not felt instantaneously at the periphery P, because the velocity of energy propagation in steel is

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The "Breaking Up" of Loud Speaker Diaphragms.—

not indefinitely large. If we see a flash of lightning the thunder does not immediately follow. There is a lapse of time whilst the sound travels from the location of the flash to the listener. The velocity of the sound is from 1,100 to 1,200 feet per second according to the state (temperature and pressure) of the atmosphere. Suppose the air could by some magical transformation process be replaced by steel, there would still be a time interval between spark and sound. In this case it would

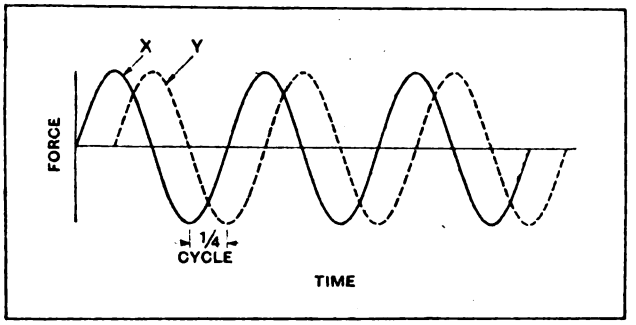

Fig. 4.—The motion of the centre is shown by X whilst the motion of the periphery, a quarter-cycle behind the centre, is shown by Y.

be smaller than for air, since the velocity of sound in steel is much higher than it is in air. The greater velocity exists by virtue of the greater rigidity of the metal steel.

The time taken for energy to travel from the centre to the circumference of the steel disc depends upon the diameter and thickness of the disc. The larger the diameter the longer the time taken, since there is a greater distance to be covered from the centre to the outside. Owing to this finite velocity of propagation of energy down the disc, it clearly cannot move as a whole, but there is a well-defined realm within which it can, for practical purposes, be regarded to move as a whole, i.e., to act like a piston.

Reduction of Output.

We postulated an alternating force which would make the disc oscillate about its central or equilibrium position. If the time taken for energy to travel to the circumference is small compared with the time taken by the disc to move outwards to the dotted position shown in Fig. 2, it can be regarded as being rigid, i.e., moving as a whole. As the frequency of the applied force increases, a point is reached when the time taken to travel a distance equal to the radius of the disc is comparable with that occupied by one-quarter of a cycle (see Fig. 4). When this occurs the disc cannot be considered to act like a piston, and the whole of it is not moving in the same direction at once. To take a concrete instance: Imagine the motion at the periphery to be one-quarter of a cycle behind the force at the centre. The relative state of affairs is illustrated graphically in Fig. 4. At the point P the centre of the disc is moving to the left whilst the periphery is moving to the right. Pausing for a moment to consider what this means, it is clear that the disc radiates sound from either side simultaneously in two directions. If the radiation near the circumference is considered to be positive, that near the centre can be taken as negative. Obviously the result is a reduction in acoustic output compared with that obtained if the disc moved as a whole in the same direction.

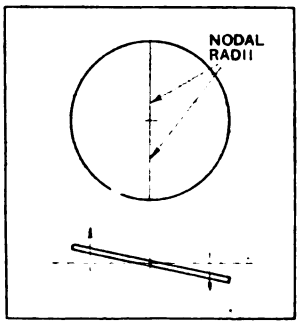

Fig. 5.—The motion of a vibrating disc at its first resonance frequency. There are two nodal radii (nodal diameter) about which the disc vibrates in opposite directions.

Effect of Disc Resonances.

At a certain frequency the disc is unusually active. This is its first natural or resonance frequency. It occurs when the energy which is reflected or diverted back from the free edge enhances that supplied by the force at the centre to the maximum extent. When this occurs the disc executes a peculiar motion. One-half moves in one direction, whilst the other half moves in the opposite direction. This is illustrated in Fig. 5. Under such a condition the action of the disc is segmental (semi-circular segment in this case), and the radiation therefrom complex. The disc can be considered—so to speak—to "break up" into vibrating segments. This breaking-up phenomenon, which occurs at a frequency above that where the disc ceased for practical purposes to move as a whole, was studied over a century ago by Chladni. He invented a simple experimental process to ascertain what happened when a disc got thoroughly excited. Now, in Chladni's time there were no valve oscillators, nor other forms of sine wave generator, so that simpler and less direct means had to be adopted to inebriate the disc. The disc was usually excited by drawing a violin bow across its edge. By sprinkling fine sand on the disc the portion in motion made the grains jump until they finally took refuge on a nodal line. On each side of this line the disc moves in opposite directions, so that the radiation from the two halves will interfere with a general net reduction in output. When the disc is excited by a central sinusoidal force, as illustrated in Fig. 2, we know very well that, despite the interference due to the two halves, the sound at resonance is much louder than that at higher or lower frequencies. To enhance the sound the proper procedure is to make use of a baffle.

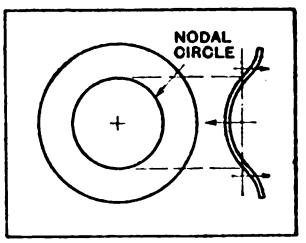

Fig. 6.—Diagram showing resonance of flat disc corresponding to one nodal circle. The inner portion is moving to the left and the other to the right at the instant under consideration.

By increasing the frequency beyond the first or fundamental resonance, it is possible to get additional modes of vibration, each being concomitant with a so-called "mode" or natural frequency. Another mode or

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The "Breaking Up" of Loud Speaker Diaphragms.— resonance is accompanied by a nodal circle, as shown in Fig. 6. Here the inside and outside of the circle are moving in opposite directions. Other frequencies give four or more radial lines instead of two, and there are also combinations of radial lines and nodal circles. On the whole the vibration and the acoustic output properties of the disc are characterised by complexity. Radial lines and circles are also found in chime bells. They are—in that connection—known respectively as nodal meridians and nodal circles. Such markings on a bell are found by striking it and searching with a form of stethoscope for points of minimum or zero sound.

(*To be concluded.*)

TRANSMITTERS' NOTES AND QUERIES

French Transmitters.

The first Congress of the Réseau des Émetteurs français, held on June 1st and 2nd, was attended by delegates from Belgium, Germany, and Hungary. The recognition by public authorities of the usefulness of amateur work was emphasised. The French Post Office has decided, as a mark of appreciation, to exonerate from wireless receiver taxes all those who have collaborated in the short and ultra-short wave researches of the official laboratories.

The chief subjects of discussion included the application of the super-heterodyne method to short waves and the piezo-electric properties of quartz. A resolution was adopted asking that the amateur wave-bands allotted by the Washington Convention should not be used by official stations.

At the general meeting of the R.E.F. following the Congress, M. J. Reyt (8FD) was elected President, Messrs. R. Desgrouas (8IH) and J. Bastide (8JD) Vice-presidents, and Messrs. R. Audureau (8CA) and R. Martin (8DI) Joint Secretaries.

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Short Waves in Austria.

With reference to the note on page 613 of our issue of June 12th, we hear that the Vienna station UOXY had, up to the end of last month, received four reports of reception from England and one from Holland. Signal strength on 10.6 metres was stated to be between R4 and R8.

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A German Amateur.

Herr Helmut Burkle, Lindenallee 59, Berlin Weissensee, a young short-wave enthusiast, would like to get into correspondence with an English amateur of about the same age (17), presumably one who can speak German fluently.

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Short-wave Working in Great Britain.

Mr. E. T. Somerset (G2DT) picked up at Burgess Hill, Sussex, on Sunday, June 16th, signals on 5 metres from G5WF and G5QB at West Hampstead, the experimental stations owned respectively by Mr. W. F. Floyd and Mr. E. J. Reid.

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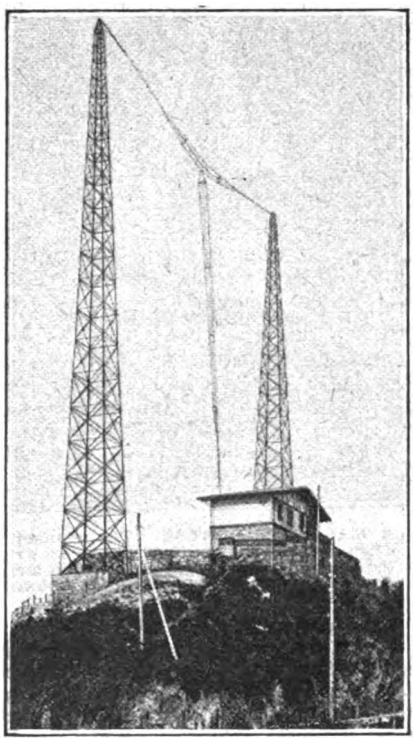
G5SW Received in Cairo.

An Egyptian correspondent speaks highly of the reception of G5SW in Cairo, stating that the relay of the Empire Day festival in Hyde Park came through without any fading, every word being distinct, and the running commentary of the Derby was also unusually clear, the cheers of the crowd and even scraps of conversation between people near the microphone being heard. He states that when "Aerial B" is used reception is usually very reliable. Incidentally, we learn that stations in South Africa seem to prefer "Aerial A," and it may prove interesting to learn which aerial is generally considered the better at various distances.



SPANISH BROADCASTING. The well-known San Sebastian station on Mount Igueldo, by the shores of the Bay of Biscay. The station operates with a power of 1.5 kW. and on a wavelength of 368 metres in common with the Seville transmitter. Programmes include frequent relays from the Madrid Studio.

Our correspondent also reports that PCJ comes in fairly strongly, but not quite up to the standard of 5SW in purity and power; 7LO (Nairobi), fairly strong but varies at times; Bandoeng, very strong, with no "background"; Drummondville, when working with London, is almost too strong in the early morning, and he has also heard Commander Byrd speaking to the American stations. The receiver used was a Det. with two L.F. stages, the last having power valves in parallel; only 50 volts H.T. is used, as more than this is found to produce distortion.

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General Notes.

Mr. H. Osborne, 77, Barrett Road, Walthamstow, E.17, asks us to state that he is carrying out tests daily and nightly until 0100 G.M.T. at his station G5NC on 21, 42 (c.w. only), and 160 metres (c.w. and telephony). Reports, especially of transmissions on 42 and 160 metres, will be welcomed and acknowledged by card.

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New Call Signs and Stations Identified.

G2DT (ex BRS 125) E. T. Somerset, Inholmes Park, Burgess Hill, Sussex.
G5DF J. D. Pinchbeck, Summerfield, Wadsworth, Hebden Bridge, Yorks.
G5FC (ex BRS 152), F. Donald Cawley, 85, Hale Road, Hale, Cheshire.
2BFL J. Batchelor, 51, Arcadia Gardens, Bowes Park, N. 22.
2BXM F. C. Mason, 37, Abbey Road, Bush Hill Park, Enfield. (Change of address).

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European Stations Heard in Australia.

Mr. G. A. Jeapes (G2XV) sends us the following list of stations heard by Mr. R. Roberts at Box Hill, Victoria, Australia :—

British : G5BY, G5YX, G5BZ, G5WK, G5MQ G2XV, G6XN, G6WY, G6WI, G5QV.
French : F8JT, F8FD, F8YPZ, F8HZ.
Finnish : OH2NM.

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Unlicensed Stations.

In addition to the two call-signs given in our note of June 12th, we understand that G6ABC (Wales) and EI5F (S. Ireland) are also being misused by unlicensed transmitters.

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Events of the Week in Brief Review.

PRISON FOR THE UNLICENSED.

No mercy is to be shown to unlicensed transmitters in Australia. According to the latest regulations issued by the Commonwealth Postmaster-General, the penalty for conducting illicit transmission will be a fine of five hundred pounds, or imprisonment, with or without hard labour, for a term not exceeding five years.

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POLICE WIRELESS IN PARIS.

A new wireless police force is to be instituted in Paris. Experiments will shortly be made in communicating from the Eiffel Tower with the police of London and Berlin.

It is stated that the "air" police will be recruited from the ranks of ex-Army telegraphists.

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FRENCH SHORT-WAVE TESTS.

The Eiffel Tower transmitter is now regularly carrying out tests on short-wave telephony. The wavelength varies between 49 and 51 metres. Experiments are usually carried out between 1130-1145, 1815-1830 and 2215-2245 B.S.T.

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GERMANY'S "WORLD" SHORT-WAVER.

From Berlin comes the report that work on the new German "world" short-wave broadcasting station is nearing completion, and that experimental transmissions are to be made at an early date. Although no definite information has been given out officially regarding the wavelength to be adopted, it is probable that the initial tests may be carried out on either 31.381 metres or 25.105 metres. The transmitting plant has been installed in close proximity to the Zeesen high-power station.

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BRITISH WIN IN FRENCH "RADIO RALLY."

The Parisian "radio rally" on June 30th, referred to in a recent issue, resulted in a triumph for Captain Leonard Plugge, who won the first prize for the most perfectly wireless-equipped touring car with his Standard saloon, "Aether III," in which an eight-valve set and loud speaker are incorporated as part of the structure.

The rally was staged between Paris and Fontainebleau, and was attended by a great number of spectators. The competition was organised by the Automobile Club de France and the Automobile Club de l'Ile de France.

ANOTHER FRENCH WIRELESS SHOW.

The town of Lille will hold a wireless exhibition from September 28th to October 7th.

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SHORT WAVES FROM AUSTRIA.

UOR2, the short-wave experimental station installed by the Vienna Ravag Broadcasting Company, now broadcasts a short programme of gramophone records on Tuesdays and Thursdays at 1300 B.S.T. and on Wednesdays and Saturdays at the end of the Vienna evening programme.

A MAGNETIC POSTER. The winning design in the competition organised by the Radio Manufacturers' Association for a poster proclaiming the Olympia Show. The artist is Mr. P. Irwin Brown.

WIRELESS APPRENTICES FOR R.A.F.

Vacancies in the Royal Air Force for six hundred aircraft apprentices between the ages of 15 and 17 are announced by the Air Ministry. The principal trades open include those of wireless operator-mechanic and electrician, fitter (aero engine, driver and armourer), and coppersmith. Full information regarding examinations and methods of entry can be obtained on application to the Royal Air Force, Gwydyr House, Whitehall, London, S.W.1.

WIRELESS BETWEEN LIGHTSHIPS.

Plans are understood to be in preparation for wireless communication between certain lightships on the East Coast of Britain and German lightships in the North Sea in order that fog warnings may be exchanged.

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41.5-METRE RELAYS FROM SWITZERLAND.

A small short-wave transmitter has been erected by the Zurich Radio Club which, by arrangement with the Swiss authorities, broadcasts the local wireless entertainments every Saturday night between 2000 and 2200 B.S.T. on a wavelength of 41.5 metres.

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MARCHESE MARCONI AND VATICAN WIRELESS.

The order for the wireless station which is to be erected in the Vatican City for the use of His Holiness the Pope and the Vatican State has been placed with Marconi's Wireless Telegraph Company, Limited.

The station will embody the latest improvements in wireless design and construction, and it is receiving the personal supervision of the Marchese Marconi. Communication will be carried out both by telegraphy and by short-wave telephony, and it is stated that the range of the station will be "world-wide."

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WAR ON BROADCAST PROPAGANDA.

A reported proposal of the Soviet Government to erect a super-power broadcasting station either at Petrograd or Moscow to transmit programmes for European consumption in German, French and Esperanto has aroused acute discussion in certain French papers (writes our Paris correspondent). The station, it appears, will be intended to "educate" Europe in the principles of Communism.

The French Press declares that this project raises "a most important problem of international law—the right of a nation to broadcast in a language other than that spoken by its subjects." It is urged that the matter should be studied by European Governments and the League of Nations.

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"GRAF ZEPPELIN'S" NEXT FLIGHT.

Repairs to the German airship *Graf Zeppelin* are nearing completion, and the date approaches when a further attempt will be made to cross the Atlantic to New York. It is understood that the arrangements made for the previous unsuccessful trip hold good for the next flight,

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and it is stated that a special radio reporter sent across from the United States will join the airship from the start, and so far as possible will send verbal reports daily on a short wavelength to 2XE (Rocky Point, New York) which, in its turn, will pass on the messages to WABC (New York) for broadcast to American listeners. It is expected that if favourable conditions prevail two-way communication may be established, and that the *Graf Zeppelin*, during the course of the trip, will be in a position to give its passengers the latest news bulletins.

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GERMANY'S WIRELESS SHOW.

The annual German Wireless Exhibition will be held this year at Berlin from August 30th to September 8th. As in previous years, the venue will be the famous Kaiserdamm grounds.

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POLISH RELAY ON SHORT WAVES.

Nightly from 23.00 to 24.00 B.S.T. the Posen short-wave station relays the local programme for rebroadcast on 30 metres with a power of some 700 watts in the aerial. All calls and announcements are given out in Polish, German, French, and Italian, and on some occasions in English. The interval signal consists of a metronome beating 240 strokes to the minute.

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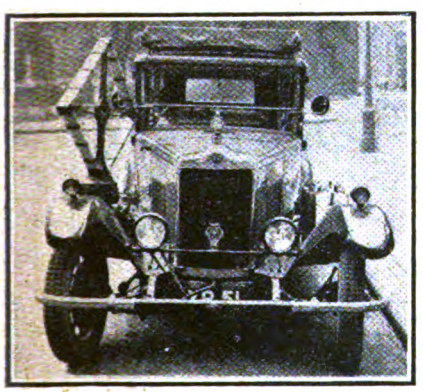
TRANSMITTING TO THE ANTARCTIC.

Known as the Byrd antenna, a special aerial system has been erected at the South Schenectady transmitting laboratory of the American General Electric Company for communication with Commander Richard Byrd's expedition now exploring the Antarctic. The aerial, which is highly directional, has been



"AETHER III," Captain Plugge's wireless-equipped car, which won the first prize in its class at the Paris "Radio Rally."

designed by Dr. E. F. W. Alexanderson, and is very similar to the other short-wave antennæ erected on the same site. At regular intervals the programmes of WGY are relayed specially for the benefit of the Byrd expedition, and, although it is considered doubtful whether every transmission will penetrate the heavy atmospherics abounding in the Antarctic regions, it is expected that Commander Byrd and his men will get much better signals than have hitherto been possible.

TELEVISION IN COLOUR.

The introduction of colour into television transmissions was carried out successfully on June 27th by the American Telephone and Telegraph Company, according to a correspondent of *The Times*. It is claimed that it is now possible to add colour without complication, and, while the pictures are still restricted to the size of a postage stamp, it is stated that it would not be difficult, although more expensive, to reproduce coloured pictures on a larger screen.

The colour transmission did not entail extensive alterations to the original equipment, the only changes being in the types and arrangement of the photo-electric cells at the sending end and of the neon and argon lamps at the receiver.

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A NEW APPOINTMENT.

Mr. H. Francis White, well known in shipping circles, has been appointed manager of the Radio Communication Co., Ltd.

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AUTOMATIC TRANSMISSION FROM THE AIR.

A small captive balloon fitted with a self-acting short-wave transmitter is the subject of a paper submitted to the French Academy of Science by the military wireless service. The apparatus transmits barometer and thermometer readings.

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SAFETY AT SEA.

Extensive revisions in maritime wireless procedure are recommended in the text of the International Convention for the Safety of Life at Sea, published by H.M. Stationery Office. The Convention was signed in London on May 31st last, and now awaits ratification by the Governments concerned. The chapter on radio-telegraphy, which relates to all ships engaged on international voyages except cargo ships of less than 1,600 tons gross, refers to the fitting of radio installations, including their technical requirements, and to the watches to be kept for safety purposes on various categories of ships.

Copies of the text of the Convention are obtainable from H.M. Stationery Office, either directly or through any bookseller, price four shillings each.

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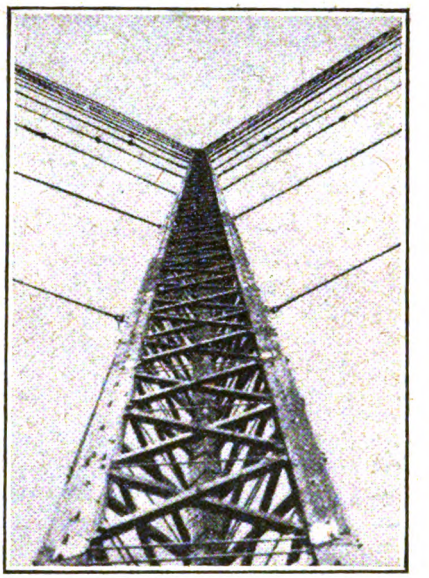
NEW EVENTS IN R.A.F. DISPLAY.

Many radio enthusiasts will find their way to Hendon on Saturday next, July 13th, to witness the Royal Air Force Display, in which wireless will play an important part.

The main event of the afternoon will consist of a great air battle and an attack on a fortified port which is occupied by a troop transport and other shipping. Six squadrons, comprising nearly 50 aircraft, will take part, including Army co-operation aircraft, single-seater fighters, and day and night bombers. During the battle an observation kite balloon will be shot down in flames, but the observer, Squadron-Leader "Sandbags," will be saved by parachute.

For the first time a squadron of Southampton flying boats will figure in the programme. These aircraft are similar to those used by the Royal Air Force for the Far East flight which concluded a 27,000 miles cruise to India, Australia, Hong Kong, and Singapore a year ago. They will leave their base at Calshot, near Southampton, and after flying over land part of the way will give



A "WORM'S-EYE VIEW" of a new Admiralty 500-ft. wireless mast at Ricasoli, Malta, constructed of wood and supported by thirty-six strands of 4½in. cable to withstand squalls.

a flying demonstration at Hendon during the afternoon.

A new feature will be the use of coloured smoke to enable spectators to follow closely the various evolutions, such as spinning, looping, rolling, and half-inverted loops, to be carried out by two pilots of the Aeroplane and Armament Experimental Establishment.

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POLICE WIRELESS DEVELOPMENTS.

Extensive developments in the use of wireless by Scotland Yard and the County Police throughout the country were forecast by Major T. H. Vitty, engineer to the Metropolitan Police, in a lecture before the Chief Constables' Association at Brighton, on Wednesday last.

Major Vitty said that the wireless transmitter at present in use at Scotland Yard had a radius of between 50 and 100 miles, but there was no technical reason why this range might not be considerably extended to permit of inter-communication between London and provincial headquarters.

The lecturer explained that the principal use to which wireless was put today was in maintaining touch with the Flying Squad cars. Other uses had been experimented with lately, notably the wireless transmission of photographs and finger prints. Tests had been conducted with the "Fultograph" and Marconi-Wright picture transmission systems

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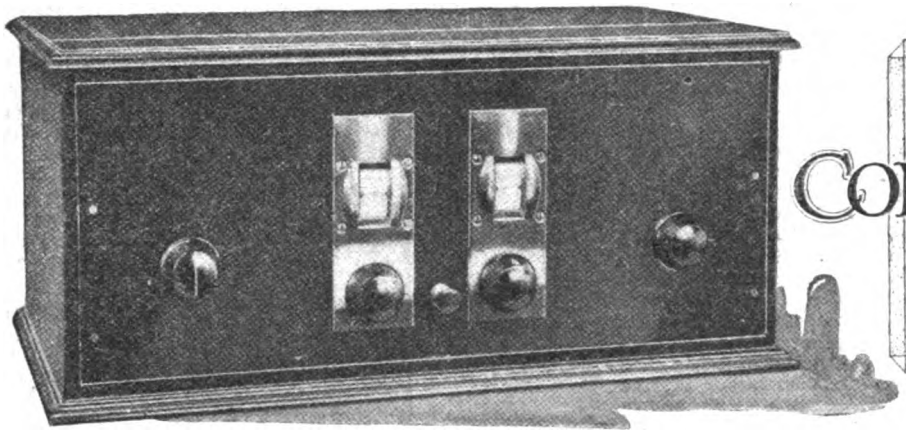

KIT CONSTRUCTORS' NOTES

The Mullard S.G.P. Master Three.

IN view of our increasingly exacting needs in the matter of selectivity it is strange that producers of "kit" sets have practically ignored the possibilities of "bottom bend" detection. The attitude of commercial set builders towards this question is quite understandable, as they clearly have good reasons for avoiding another adjustment—of detector grid bias—that will require periodical, albeit infrequent, attention, but it is reasonable to assume that anyone who can assemble and wire a set is capable of carrying out this simple operation.

While anode detection is by no means a complete solution in itself of all interference problems, it is a readily demonstrable fact that a receiver with circuits of reasonably low H.F. resistance will be more selective when this system of rectification is used, as compared, of course, with the rival leaky grid condenser method. The relative merits of both systems are familiar to most readers; but perhaps there is a tendency to lay undue stress upon the lack of sensitivity of the anode bend detector and to forget that it is included in some of the best long-distance receivers—as, for example, the "Everyman Four." Speaking from a strictly practical point of view, it is not misleading to go so far as to say that there is little to choose, from the point of view of range, between the two systems. The accuracy of this statement is easily checked by constructors of the Mullard "S.G.P. Master Three" receiver, which, though primarily intended for anode bend detection, is readily convertible in a few moments for a comparative test.

Tuned Anode H.F. Coupling.

In its general circuit arrangement (shown diagrammatically in Fig. 1) the set does not include any radically new features. Aerial coupling is through an "aperiodic" transformer, with alternative tappings on its primary winding for adjusting selectivity; as pointed out in the descriptive booklet, conditions may arise—as, for instance, when the local station is not operating—when it is desirable to take advantage of the increased sensitivity generally afforded by a "tight" aerial coupling.

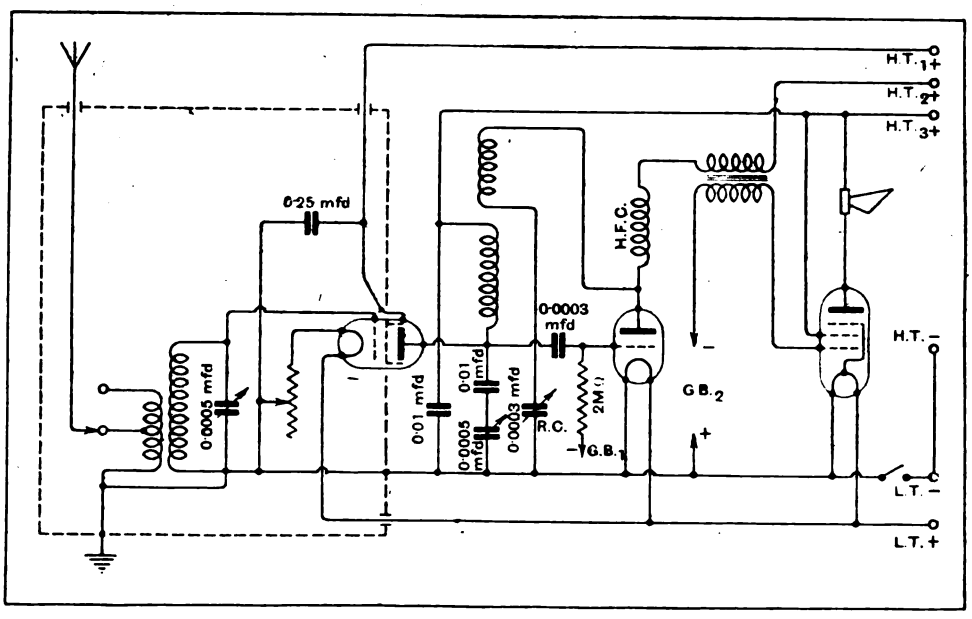

Fig. 1.—Complete circuit diagram, showing screening of grid circuit components and protective condenser in series with anode tuning condenser.

A simple tuned anode circuit is used to couple the screen-grid H.F. valve to the detector, and consequently a blocking condenser, with its associated leak, is of necessity included in the grid circuit of the latter valve. This addition is not accompanied by any observable ill effects, and the possibility of running into grid currents is almost precluded by the use of a "D" type detector valve.

Volume is controlled by operation of the S.G. valve rheostat, which is connected

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Kit Constructors' Notes.—

in the negative filament lead, with the consequence that an increase in its resistance will cause a decrease in emission, and, at the same time, will impress a negative bias on the grid.

Reverting to the intervalve coupling, it will be seen that one side of the anode tuning condenser is at earth potential, and that the oscillatory circuit is completed through a fixed condenser of 0.01 mfd. Another fixed capacity of the same value is connected in series with the tuning condenser; this serves no other purpose than that of a protective device in the event of a short-circuit between the fixed and moving vanes. In justice to the makers of the J.B. variable condensers, one should hasten to add that such a fault is unlikely to arise, as the components are accurately and strongly built. This series condenser is an addition to the original design, its connections being described in a leaflet accompanying the descriptive literature.

Danger to Valve Filaments.

An important point emerges with relation to this question of protective devices. It will be seen that negative sides of both H.T. and L.T. batteries are connected together and to one side of the on-off switch; if this switch is at "off" a high-tension short-circuit such as that described above, or, indeed, an accidental short-circuit to earth between any point connected either directly or through a low resistance to an H.T. positive terminal, will have the effect of burning out all the valves —provided, of course, that the source of H.T. supply is of comparatively low internal resistance. It is admittedly a fact that the filament circuits of most "kit" sets are arranged on similar lines, but the present writer admits his complete inability to see any justification for a scheme that increases the risk of damage due to accidental short-circuits.

A negative voltage for the detector grid is applied from a bias battery which also supplies pressure for the pentode output valve. These two valves are linked by a Mullard "Permacore" transformer, which is capable of fulfilling the rather exacting task of functioning in the plate circuit of an anode bend rectifier. Capacity-controlled reaction on normal lines is provided, one side of the feed-back condenser being earthed to the metal panel.

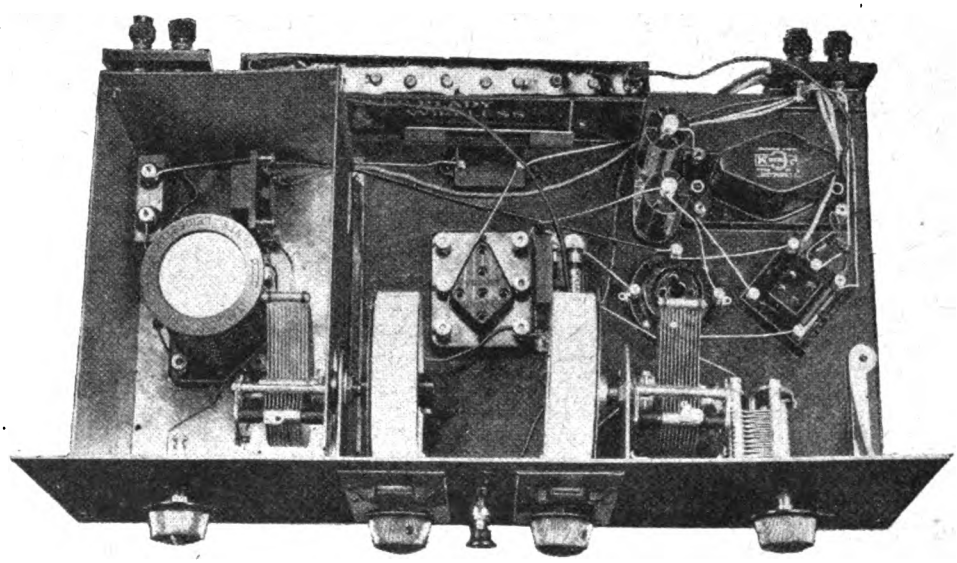
Turning to practical details of construction, the H.F. valve grid circuit is completely screened in a copper box. This plan is much more convenient than the alternative of enclosing the plate circuit components, and its adoption makes for a more compact set. The S.G. high-frequency amplifying valve is mounted horizontally, and its anode section projects through the metal screening case, which is supplied in sections ready for assembly; it is intended that wiring should be completed before its vertical members and lid are fixed in position. By these means the difficulty of working in a restricted space is avoided.

Colvern or Tangent coils are specified for the set; those included in the specimen receiver submitted for test were of the latter make. High-frequency inductances are of vital importance in any set, and the windings in the present instance seem to have been exceptionally well chosen, particularly in the case of the medium-wave coils, which are as near as makes no matter to the ideal specification for their diameter.

Performance on Test.

The use of special J.B. tuning condensers contributes materially to the good appearance of the set; these components are fitted with edgewise drum dials, and are driven by a friction disc (controlled by a panel knob) which is operated through a reduction gear. In other matters conventional practice is followed, a wooden baseboard marked with component positions and wiring being used in conjunction with a metal panel that is supplied ready drilled.

When making initial tests on the medium waveband the set was found to lack complete stability at certain points of its tuning scale. Self-oscillation could be easily checked either by dimming the H.F. valve filament or by setting screening grid voltage at something other than the optimum value, but these expedients cannot be considered as being good practice or even fair to the set, and attention was turned towards the screening case, of which some of the joints were imperfectly closed, particularly those between box and panel. Insertion of strips of copper gauze—an invaluable aid to the experimenter in these days of isolated circuits—proved to be an effective and complete cure. Tuning was found to be comfortably sharp, and overall selectivity, as was to be expected, of an exceptionally high order. Sensitivity



Plan view. Lid of screening box removed and grid coil in position.

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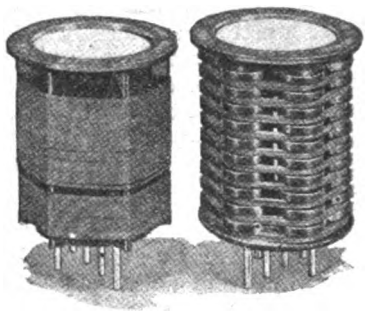
Kit Constructors' Notes.—

was well above the average standard; that this was largely due to pure H.F. amplification was proved by the fact that reaction was by no means necessary for long-distance work. Indeed, it would be a good plan to make provision for optional direct connection of the reaction condenser between detector anode and earth, thus dispensing with intentional feed back and at the same time improving detection efficiency.



Medium- and long-wave interchangeable coils.

On the long waves, as on the medium band, there was found to be some instability, but matters were, again, improved by paying attention to screening-box joints. At some settings it was observed that self-oscillation was produced when a station was tuned in, but not when the two circuits were brought into resonance at an adjacent wavelength on which there were no incoming signals. This is always a fairly sure indication that H.F. energy is finding its way into the L.F. amplifier, and accordingly a 0.25 megohm resistance was inserted between the grid of the pentode and the "G" terminal of the L.F. transformer, with the desired results. These experiments are described with a view to helping those who may encounter similar effects; in many cases no troubles are to be anticipated, as H.F. instability is largely dependent on the characteristics of the particular S.G. valve used. To be on the safe side, it is recommended that the contiguous flanges of the screening box should be scraped bright, and that particular care should be taken in fitting together the sections, not forgetting the lid.

Tangent dual-range coil with switch in base.

Plug-in interchangeable coils are used to cover the two wave-bands in the standard model, but a modification is described in which two coil assemblies, complete with built-in wave-changing switches, may be used in an otherwise similar circuit arrangement. Due to the necessarily reduced dimensions of the coils, the receiver in which they are used will have a somewhat less extended range, and its selectivity is bound to be slightly impaired.

KIT CONSTRUCTORS' PROBLEMS.

The Information Department Service has been extended to deal with problems encountered by builders of "kit" sets discussed in these pages. Receivers already treated are the "New Cossor Melody Maker," Osram "Music Magnet," Mullard "Master Three Star," Six-Sixty, "Mystery Receiver," Ferranti "Screened Grid Three," Farnio "Screened Grid Three," Dubilier "Toreador Screened Grid Four," and the McMichael "Screened Three." The service is subject to the rules printed in the Readers' Problems' section.

An Idle Terminal.

For use with my "1929 Cossor Melody Maker" I have obtained an eliminator which has two output terminals marked 60 volts and a third marked 120 volts. One of the former is intended for feeding the screening grid and the 120-volt connection will be for the main supply; to what point should the other terminal be joined? B. H.

The anodes of the valves in this set are fed with a common H.T. voltage, a lower pressure, of course, being applied to the screen of the S.G. valve. This being so, the extra connection would appear to be unnecessary, so the terminal may be left "free." Possibly it might be an advantage to use it for feeding the detector anode circuit, but a voltage of 60 is rather too low for a high-impedance valve. It may be, however, that on the very light load imposed by this valve the actual voltage will rise to a sufficiently high value: it must be realised that the voltages indicated on an eliminator are seldom more than a rough approximation, an average current consumption being assumed by the makers.

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Wood or Metal?

Will you please tell me whether it is best to use a wood or a metal cabinet for my "Osram Music Magnet"? C. S.

It is injudicious to take any liberties with a set including ganged tuning controls, and on the whole we think you will be wise to use a wooden cabinet. It will be realised that the inductance of tuning coils is reduced when a mass of metal is brought into proximity with them, and, as it is unlikely that both plate and grid coils will be equally affected, the use of a metal container introduces an element of risk.

We should add, however, that in any case this effect cannot be very serious, and if you are specially inclined towards the use of metal it would be worth while going to the trouble of making an initial test by placing sheets of the material you propose to use in the positions that will be occupied by the top, sides and back of the case, and noticing if there is any obvious falling off in the performance due to these additions.

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Two-stage L.F. Amplifier.

Do you think that it would be possible to make up a set on the lines of the Ferranti "A.C. Three," but with two high-frequency stages coupled by R.F.2 transformers (as at present used in the single stage)? If possible, I should like to use a simple vertical screen between each stage, instead of enclosing the various components associated with each circuit in metal boxes. G. R. B.

It is difficult to give a definite answer to your query without carrying out some practical experimental work, but on the whole we doubt very much if your proposed receiver would be completely stable over the normal tuning ranges. The long-wave windings are astatically wound, so on this band it is quite probable that you would be successful, but for short-wave reception it is more than likely that stability would be lacking: this in spite of the extensive decoupling devices that are included. It would certainly be safer completely to screen the individual circuits.

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Adding L.F. Amplification.

As you will see from the heading of my letter, I live in a district remote from broadcasting stations, and am accordingly compelled to consider the addition of another L.F. stage to my Cossor "Melody Maker." Would you advise resistance or transformer coupling? S. L. L.

Good results can be obtained by adding an extra stage, coupled by either method; but on the whole we are inclined to recommend that you should interpose a resistance coupling between the detector valve and the extra L.F. amplifier. The overall amplification ordinarily obtainable from two modern transformer-coupled stages is likely to be excessive for ordinary requirements, and so, if you prefer to adopt it, we suggest that a volume control resistance should be shunted across the primary of the first transformer.

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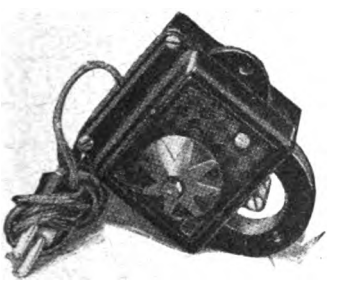
A Review of Manufacturers' Recent Products.

LOEWE LOUD SPEAKER UNIT.

This cone loud speaker movement is assembled in a neat moulded container, and consists of a generous-sized horseshoe magnet fitted with a single pole-piece and a reed armature arranged crosswise with respect to the arms of the magnet. The single pole-piece is not fixed to one end of the horseshoe magnet, but located approximately half-way along one of the arms. One end of the armature is fixed to the extreme end of the magnet on the opposite arm to that carrying the bobbin. The armature, therefore, completes the magnetic circuit. A small fixed condenser of the Loewe vacuum type is connected across the bobbin. The distance between the reed and the pole-piece is adjustable.



Loewe adjustable reed type cone loud speaker movement.

This unit is being offered at 13s. 6d. by the Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15.

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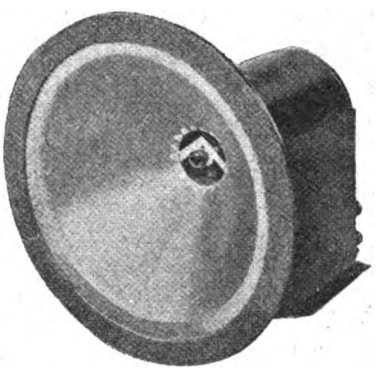
"SUPER" MOVING COIL LOUD SPEAKER.

The model submitted for test was for D.C. mains excitation, and found to consume 0.14 amp. at 220 volts, representing 30 watts approximately. A low-resistance coil is fitted and accurately centred in a gap of small cross section. The centering device assures that the coil has a parallel motion, an important feature in view of the small gap employed. Moreover, examination showed that considerable force would be required to displace the coil and cause it to touch the sides of the gap. A Ferranti input transformer is used and is accommodated in the base. Tested on a high quality amplifier, it showed that the performance was well up



"Super" moving coil loud speaker for 220-volt D.C. mains with input transformer mounted in the base.

to that of the standard laboratory instrument. A baffle board 3ft. square was fitted for the purpose of judging the performance. High and low notes were well in evidence, and the response to the middle register appears to be well balanced. The diaphragm is 9in. in diameter, light but reasonably rigid, and a leather surround is employed. The frame supporting the diaphragm is bolted to the face of the pot.

The sole agents are Messrs. W. Pearson and Co., 41, Great Charles Street, Birmingham, and the price is £6 10s. A 6-volt model for accumulator excitation of the pot is available at the same price, but either model can be supplied without the transformer at £5 10s.

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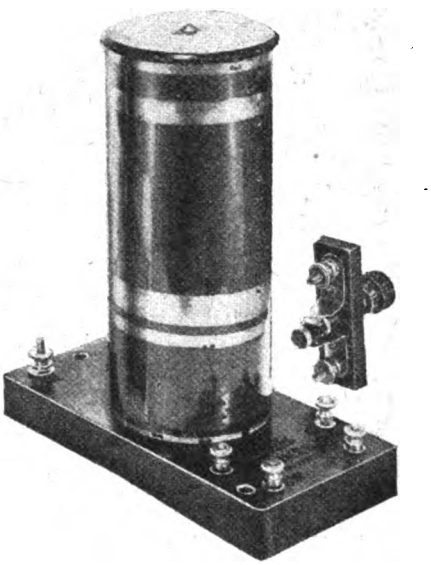
WATMEL TWO-RANGE AERIAL TUNER.

It is a truism that events move in cycles, and this appears equally true in the case of certain wireless components. Before broadcasting begun, all-wave tuners were the rage, but these were subsequently displaced by interchangeable coils. Once again they are enjoying a measure of popularity, but in a modified form.

The Watmel version of the modern two-range tuner takes the form of a cylindrical tube 5in. long×2⅛in. in diameter, on which is wound four coils; a medium-wave coil with a reaction winding close coupled and a loading coil also with a reaction coil. The two reaction windings are connected permanently in series; so also are the tuned coils, but a switch is provided which short-circuits the loading coil when receiving on the 250- to 600-metre band.

The medium-wave coil is tapped for attachment of the aerial, but tests show that selectivity can be improved, especially on the long waves, by connecting a 0.0001 mfd. condenser between the aerial and the tapping.

The wavelengths covered when connected in this manner to an average-sized receiving aerial and used with a 0.0005 mfd. variable condenser were found to be 214 to 600 metres and 840 to 1,900 metres. A panel switch is included, and the price is 12s. 6d. The makers are the Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware, Middlesex.



Watmel two-range aerial tuner with panel mounting wave-change switch.

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"WATES" METER CASE.

The Standard Wet Battery Co., 184-188, Shaftesbury Avenue, London, W.C.2, have recently placed on the market a small case, covered in imitation leather, for the "Wates Volt-amp." meter. At a price of

"Wates Volt-amp." meter in case.

2s. 6d., this container should find a ready demand, since it affords a measure of protection against dust and accidental knocks.

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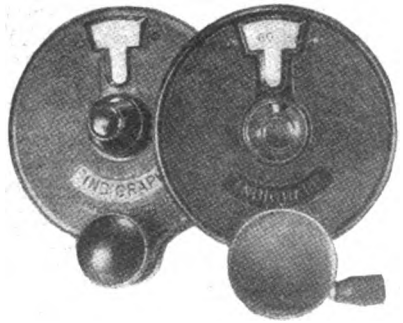
IGRANIC "INDIGRAPH" DIALS.

The latest type of Igranic "Indigraph" vernier dial incorporates a number of new features, and in addition is a sound workmanlike job. The shell consists of a handsome moulding with a window through which the graduations on the dial appear as the knob is rotated. A 0-100 scale is favoured.



Igranic "Indigraph" dials. The two-speed dial is ideal for short-wave sets.

The dial consists of a translucent material, and by fitting a small lamp behind the panel with an opening in line with the dial window it is possible to illuminate the scale and thus facilitate reading in dark or shaded corners.

The ordinary "Indigraph" has a reduction ratio of approximately 8 to 1, and is entirely free from backlash. This is offered at 6s. A pair of spanners for fixing the dial is included in each carton.

A new two-speed model with a micrometer adjustment is now available, and should be particularly useful for use on short-wave sets. The micro adjustment has been redesigned, and the new model is, in every respect, superior to its predecessor. The ratios are 8 : 1 and 500 : 1 approximately. The price of this model is 9s. 6d., and the makers are the Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4.

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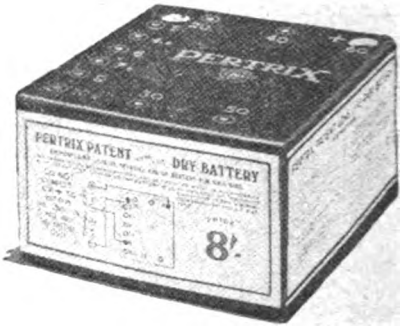
PERTRIX H.T. BATTERY.

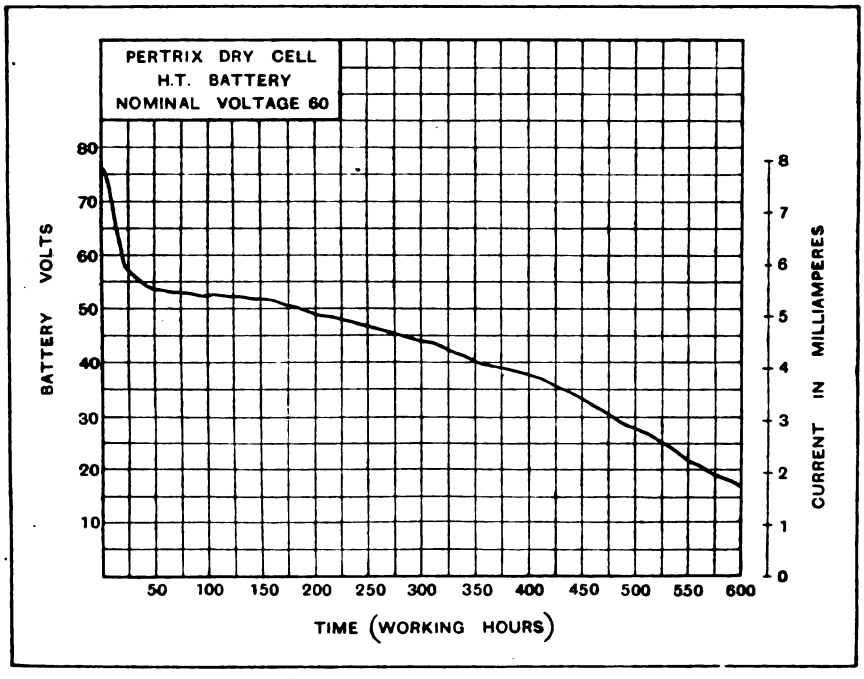
The model dealt with in this review has a nominal voltage of 60 and is provided with tappings at 1½-volt intervals from the negative end up to 10½ volts + and thence at intervals of 10 volts. The object of this is to enable grid bias up to −10½ volts to be drawn from the H.T. battery.

The discharge test was commenced at approximately 8 mA.; the terminal voltage at the beginning reading 76. This fell rapidly during the first few hours and eventually settled down to a steady value just over 50 volts. After 100 hours, actual working time, the voltage commenced to fall steadily until the battery was exhausted. There was no natural "cut-off" unless the slight change in the slope of the curve after 400 hours' work can be taken as the "cut-off" point. Incidentally, this corresponds approximately to a state of the battery where the voltage has dropped to 0.9 volt per cell. Since it is often desirable, in the interests of economy, to keep a battery in commission until the volts per cell fall to 0.75,



Pertrix 60-volt battery with tappings for grid bias.

the useful life of this model may be taken as 470 working hours.



Discharge curve of Pertrix 60-volt dry cell H.T. battery.

This model is offered at 8s., and is supplied by Pertrix, Ltd., 120, Tottenham Court Road, London, W.1.

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Catalogues Received.

Lissen, Ltd., Friars Lane, Richmond, Surrey. Illustrated broadsheet of Lissen components.

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Messrs. Wilkins and Wright, Ltd., Utility Works, Holyhead Road, Birmingham. — Illustrated folder of "Utility" switches, condensers, and drum controls.

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London Electric Wire Co. and Smiths, Ltd., Church Road, Leyton, London, E.10.—Descriptive leaflets of "Lewcos" dual range coils, and 48-page catalogue of "Lewcos" radio products.

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CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

SHORT-WAVE RECEPTION.

Sir,—With reference to the letter from Mr. A. G. Faithfull in the issue of *The Wireless World* for June 12th, the reception of short wave beam stations in directions other than that of the main beam is common experience, and with high-power transmitters and sensitive receivers is quite to be expected.

I think Mr. Faithfull is under some misapprehension regarding the actual nature of the transmission from beam stations. The main objects of the beam system are (1) to economise power by directing the greater part of the energy radiated from the aerial in the direction of the receiving station and (2) to minimise the fading which inevitably occurs on short waves. It is also true that interference with other services not in the line of the main beam is reduced, but the idea that it is impossible for a receiver not in the line of the beam to "tap" the transmission is quite fallacious, though, of course, in the case of the beam telegraph services reasonable privacy is ensured by high speed transmission.

A beam transmitting aerial is usually arranged to confine most of the radiated energy to a sector of a few degrees, and the greater the extent of the aerial the sharper the beam. Although the concentration of energy in this main beam may be such as to effect a saving of power of hundreds of times compared with a non-directional or, more correctly, an omni-directional aerial, smaller subsidiary beams are also radiated in other directions, not intentionally, but as an inevitable result of the use of beam aerials of the only type at present available for practical commercial use. The number, sizes and directions of these subsidiary beams depend on the type and dimensions of the aerial, and the narrower the main beam the smaller and more numerous the subsidiary beams. Although the amount of energy radiated in the "subsidiary" directions is only a small fraction of the total, it is sufficient, except under very bad conditions, to produce a signal in a sensitive receiver. It has been frequently indicated by the feats of amateur transmitters that a radiated energy of a few watts on short waves is capable, under favourable conditions, of producing signals practically all over the world. There are certain directions, at least according to approximate theory, in which no energy is radiated from a beam aerial, but at distances greater than a hundred miles or so the scattering and bending effects of the upper atmosphere play an important part, and signal strength tends to become equal in all directions except that of the main beam and, perhaps, that directly behind the reflector. One might, however, expect fading to be worse in the theoretical "zero" directions than elsewhere.

Considering everything, it would be rather remarkable if the stations referred to by Mr. Faithfull were not audible in West Africa, but the case of Huizen's East and West transmission appears to be exceptional. I do not know the type of aerial in use at this station. ERIC MEGAW.

Imperial College Union,
South Kensington, S.W.7.

RADIO EXPORTS.

Sir,—When I was in England in July last there was an instructive lecture given by a high official concerning Empire marketing, and in his lecture he dwelt very emphatically concerning odd parts and manufacturers helping the importer by sending some odd spares in small essentials. At the time I remarked "how true," and this little experience on my return to India will illustrate how essential it is to add or enclose in the carton everything necessary to fix the unit, whatever it may be, to the baseboard, panel, etc. For instance, on the outside of one carton of the many little gadgets I ordered it says, "Three spring clips are supplied." No such clips were in the carton, and in every case all screws to pin the unit down to the baseboard were missing, and various nuts and screws were *non est*. The Customs had certainly made an extensive hunt right through to discover "hidden pearls." Every wrapping had been undone—contents pushed in anyhow, and I cannot say whether the manufacturer does or does not include such wood and other screws necessary, for none was found. Now what does this mean in a country where it is not possible to walk 200 yards and obtain what you want? It may be 200 miles, and then meet with disappointment. Now all this is destructive, and no remedy has been suggested. I therefore ask all British manufacturers to close their cartons with a slip to say that it contains all nuts and screws to finish the job. We have no redress against the Customs, but the wildest of dreams may obtain somewhat of a hearing if genuine British goods said to contain so and so are missing.

The British manufacturer should also consider the Wireless Act in India, by which, without an importation licence, no more than one receiving set *a year* may be imported, or component or parts equivalent to such, including spares. What is one receiving set? No one seems to know, with the result that a few terminals and odd wire and aerial insulators are held up for weeks as constituting one receiving set! It is not the Customs duty, but the holding up that one objects to. The India market may not at present be a potential proposition, but it will be. There are 320,000,000 people in this country, a population not to be despised where radio is concerned. May I suggest that the Radio Manufacturers' Association takes some notice of the difficulties of importing British goods into this country? "RADIOX."

Roorkee, U.P.

"WIPE-OUT" AREA AND THE ETHER SEARCHER.

Sir,—May I be permitted to say a few words regarding a paragraph on the "Tyranny of a too-powerful local station and the ether searcher" in your issue of June 12th?

When the "Brookman's Twins" come into operation I venture to think that the future trend of broadcast receiver design will be to a greater waveband extension by the incorporation of short-wave reception in all but "local" sets.

That "nation shall speak peace unto nation" *via* short waves, and that the present "broadcast" bands will be used for "local" work on the lines of our regional service, seems probable internationally in the near future.

An efficient double duty receiver incorporating a tuned S-G H.F. stage has recently been designed and developed in the U.S.A., which by means of interchangeable coils tunes from 14 to 500 metres, and on this side of the Atlantic several commercial firms have marketed apparatus on similar lines, and have been mentioned in your recent issues. When once the art of "pulling-in" short wavers has been mastered it affords splendid opportunities for alternative programmes even with a good 0-v-2, although anyone with S.W. experience knows how "cranky" these waves are at times, but with modern tendency towards further efficiency on the H.F. side great possibilities await us on these lines. (Possibly even a simple anti-fading device.)

A knowledge that these irregularities—the "skip-distance" of the wave—is dependent upon the particular wavelength, time of day, atmospheric conditions, location, etc., will make reception of these transmissions just as popular as many "broadcast band" foreign receptions are to-day, which, as we all know, also have irregularities. Witness the reports on our own 5GB, which, by the way, I have received constantly at full strength over one thousand miles distant, but depending upon atmospheric conditions, location, etc.

Antrim, Ireland. W. E. M. CROOK.

B.B.C. PROGRAMMES.

Sir,—No doubt the indifference of the programmes of the B.B.C. during the last year or so is accounted for by the unhappy atmosphere which seems to pervade Savoy Hill.

Government control and red tape having proved a failure, why not put programmes in charge of those who *understand* the entertainment business? S. SLADE

Nayland, Colchester.

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By Our Special Correspondent.

Prague Plan in Action.—London Regional's Aerial.—Anniversary of the Surprise Item.

5XX Controls the Ether.

How many listeners heard Daventry, 5XX, filling the rôle of ether policeman on June 30th and July 1st? On both these nights for a few hours after "close-down" 5XX relayed telephonic instructions from the Keston receiving station addressed to various broadcasting stations in Western Europe which were found to be straying from the new frequencies allotted to them under the Prague Plan.

oooo

Measurements at Brussels and Keston.

The innovation was the outcome of an arrangement between the B.B.C. and the wavelength checking centre at Brussels. Measurements were taken both at Brussels and Keston, and, after notes had been compared *via* a private line, the results were passed on to 5XX. At nearly all the broadcasting stations west of Frankfurt official listeners were tuned-in on Daventry's wavelength in readiness for any instructions sent out. A similar arrangement operated successfully in Eastern Europe, measurements being compared by Prague and Koenigswusterhausen and the results transmitted from the latter station.

oooo

Is the Prague Plan a Success?

Now that the Prague Plan has held sway for a week the prevailing impression is that it represents the best solution of the wavelength problem since 1926, when the Geneva scheme was first fashioned.

For a few weeks before the change on June 30th the Brussels scheme had been giving satisfaction in its own sphere, but we must remember that it omitted countries like Russia, France and Spain which are now included in the happy family.

oooo

Hasty Judgment.

At the time of writing it is still too early to pass judgment on the scheme as a whole. In my own case I was tempted to do so on July 1st when my reception from London was ruined by an outrageous whistle. The noise stopped, however, when the man opposite, owner of a o-v-2 swinging coil set (1926 vintage), retired to rest.

oooo

Progress at Brookman's Park.

Two of the four masts at the Brookman's Park regional station are now supporting a twin-wire aerial, but, according to Savoy Hill, this is no indication that tests are to begin immediately. A considerable amount of apparatus has still to be delivered, and it is improbable that the first transmissions will go out before the end of this month.

oooo

B.B.C. as Pamphleteers.

To save members of the Technical Correspondence Department from nervous breakdown when London Regional 1 supersedes 2LO, nearly a quarter of a million copies are being printed of a new "Selectivity" pamphlet, which will shortly be distributed gratuitously to all who apply for it. A second pamphlet is being prepared to assist listeners in areas of poor signal strength. I can imagine trouble if the latter booklet were sent in error to a resident at Brookman's Park!

oooo

Fifty-two Surprises.

The "Surprise Item" remains one of the brightest spots in the programmes, and, although the anniversary of the first of the series was celebrated last week, the B.B.C. still contrives to invest the item with the stunt flavour which was so welcome in the old days.

Among the fifty-two surprises of the past year, probably the most original was the relay from the signal box at King's Cross. Other outstanding items were the "red hot" dramatic criticism by two well-known authorities immediately following a broadcast play; the relay from film studios at Elstree; Tommy Handley's "General Election," and the playing of gramophone records—backwards!

oooo

Grid Leak in Song and Story?

While on this subject it occurs to me that the Surprise Item might provide a fitting opportunity to do homage to the grid leak, the patent of which expires in October. On the day that the patent dies what would be more appropriate than a reverently prepared programme entitled, say, "Apotheosis of the Leaky Grid," in which this valuable component would be honoured in song and story? It is difficult at the moment to recall what the poets have sung about the grid leak, but I have no doubt that by October the B.B.C. programme department could ferret out some noble tributes. And on the musical side, what has Honegger to say?

oooo

Talks on Flying.

A new chapter in the history of didactic broadcasting opens in September next, when the B.B.C. begins the first programme issued under the auspices of the Central Council for School Broadcasting, a body which is entirely independent of the B.B.C.

The syllabus appearing in the new B.B.C. booklet "Broadcasts to Schools," extends from September 23rd to December 13th, but a valuable feature to school teachers, I imagine, is the inclusion of the broad outline of the programme extending to June 30th, 1930.

A new venture is a series of fortnightly talks on Flying by Squadron-Leader W. Helmore, M.Sc., R.A.F., of the Royal Aircraft Establishment, Farnborough.

oooo

By Special Request.

A disgusted listener telephoned to the offices of the American National Broadcasting Company during a musical performance.

"Do you ever play anything by request?" he asked.

"Sometimes," was the reply.

"Then," said the listener, "I'd be glad if you'd play draughts."

FUTURE FEATURES.

London and Daventry.

JULY 15TH.—"Versailles," a French Feature Programme.
JULY 16TH.—The Northern Command Searchlight Tattoo, S.B. from Leeds.
JULY 18TH.—Alhambra Ballet Music.
JULY 20TH.—Running Commentary on the Final of King's Prize, relayed from Bisley.

Daventry Experimental (5GB).

JULY 18TH.—Launching of H.M.S. "Exeter," H.M. Dockyard, Devonport, S.B. from Plymouth.
JULY 19TH.—"Followers," by Harold Brighouse.

Cardiff.

JULY 16TH.—A Penillion Recital.

Manchester.

JULY 15TH.—A Concert from Morecambe.

Newcastle.

JULY 19TH.—Orchestral Concert from the North-East Coast Exhibition.

Glasgow.

JULY 16TH.—Scottish Concert.

Aberdeen.

JULY 16TH.—"Scots Blend."

Belfast.

JULY 19TH.—"Carmen," by Bizet.

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"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Neutralising the S.G. Valve.

I have tried to put into effect the plan suggested in your recent article "More Amplification from Screen-Grid Valves," but have so far been unable to obtain satisfactory neutralisation over the whole of the medium broadcast waveband. The set is partially stable, but only when the neutralising condenser is set at minimum; from this it might be assumed that "balancing" is unnecessary in my particular case, but this is not so, as complete disconnection of the condenser makes matters very much worse. The performance of the set is already so promising that I mean to persist in my efforts. Can you give me any hints as to steps to be taken? An H.F. transformer is used as a coupling.

C. C. D.

Before making any alterations we think you would be well advised to assure yourself that your neutralising condenser has not got an excessively high minimum capacity, although there is no reason why the majority of standard components should not be used in this particular circuit arrangement.

If the condenser is normal it can be assumed with some confidence that your trouble is due to a balancing winding with too many turns; this is particularly likely to be the case if it is tightly coupled to the primary, and we suggest you should try an experimental reduction. In many cases a single turn, or even less than a turn, will be found to be ample, particularly when the capacities to be balanced out (those in the valve and incidental) are extremely small.

oooo

Sense of Reaction Winding.

It seems to me that there should be a method of determining the correct connections of a reaction coil, and that it should not be necessary to find this out by trial and error. Is there any simple rule? W. T. P.

Provided that the convolutions of the coils are exposed and can be traced out to their terminals, it is an easy matter to determine the correct connection for the reaction coil.

The imple rule is that if we imagine oscillatory current to originate respectively on grid and plate of the valve, they should flow outwards through the coupled coils in opposite directions. This will be made clear by a consideration of Fig. 1, in which diagram (a) shows the correct connections.

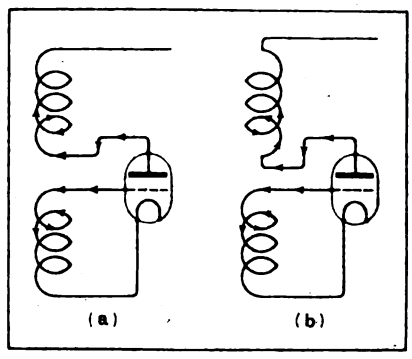

Fig. 1.—Illustrating an easily-remembered rule for determining reaction coil connections.

This rule holds good in any form of reaction circuit, whether feed-back is controlled by moving the relative position of the coils, or by varying the capacity of a feed condenser, as in the majority of modern circuits.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World", or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

Measuring Eliminator Output.

It is realised that an ordinary voltmeter connected across the output terminals of an eliminator will not give a true reading of the voltage existing under working conditions, but is it not a fact that it will show a true reading as long as it is connected in position?

In my particular case a simple A.C. eliminator, with a single voltage output, is used in conjunction with a three-valve receiver, and the meter (0-150 volts, 200 ohms per volt) shows a reading of 140 volts. The set seems to work extremely well, but can it be assumed that the voltage shown on the meter is that actually delivered to the set? V. S. C.

Yes, as long as the meter is connected it will show a true reading, but, as you apparently realise, there will be a rise in voltage when it is removed. It may be pointed out that if the meter were replaced by a fixed resistance having the same value as that of the instrument (30,000 ohms in your case), the voltage reading as indicated would be maintained.

oooo

Scope of Volume Control.

Is there any serious objection to using a pentode in the output position of a set embodying the general circuit arrangement of the "S.G. Regional Receiver?"

In order to obtain the best possible quality, it is realised that, when receiving strong signals from near-by stations, a good deal of the magnification afforded by the combination of detector and L.F. transformer coupling must of necessity be abandoned. I am uncertain as to whether a variable resistance shunted across the transformer primary will enable me to make a sufficient reduction in the L.F. voltage applied to the pentode when the detector is fully loaded. J. V. R.

You need have no doubts on these grounds; by setting the volume control resistance at a suitably low value, it is possible to bring about a very considerable reduction in the signal voltage passed on to the next valve. Actually, the regulation range of this form of control is greater than is normally required.

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Comparative H.F. Measurements.

I am engaged in rebuilding my "Everyman Four" receiver; it is being converted for use with a screen-grid H.F. valve, and at the same time a separately tuned aerial circuit is being added, in order to provide the extra selectivity which it is expected will shortly be necessary in this district. It seemed to me that there was a good opportunity of comparing the relative merits, from the point of view of H.F. amplification, of the original and of the new circuit arrangement, and I have endeavoured to make measurements in the manner suggested in your issue of June 12th under the heading of "The Design of H.F. Transformers." Unfortunately, I have been unsuccessful, and all readings obtained are quite indefinite. Can you suggest a likely cause of failure? E. L.

It seems that the most probable reason for your inability to obtain definite comparative readings is that the voltages applied from your oscillator to the grid of the H.F. valve are either excessively small or perhaps even excessively large, but there should be little difficulty in so arranging matters that a suitable impressed voltage is obtained.

Your first step should be to try the effect of varying the output of the oscillator; assuming this to be of the parallel-feed, single-coil type described by our contributor and shown in Fig. 8 of the article to which you have referred; this may conveniently be done by altering the applied H.T. voltage. Again, a similar effect may be obtained by altering the coupling between the oscillator coil and the two-turn pick-up coil; you might possibly find it an improvement to use a single-turn coil for the transfer of energy.

It is possible that your connections are not correct, and, as a guide, we show a suitable arrangement in Fig. 2. From this you will see that the existing components in the H.F. grid circuit of the set itself should be disconnected and by the coupling coil and a bias her alteration is necessary insertion of a low-reading milliammeter or a microammeter (the latter if your coupling resistance is of a high value) in series with the detector grid.

We would emphasise the point that the oscillator should be placed at some distance from the set, and that the leads between the pick up coil and the grid of the H.F. valve should be non-inductive —i.e., they should be run parallel and close together.

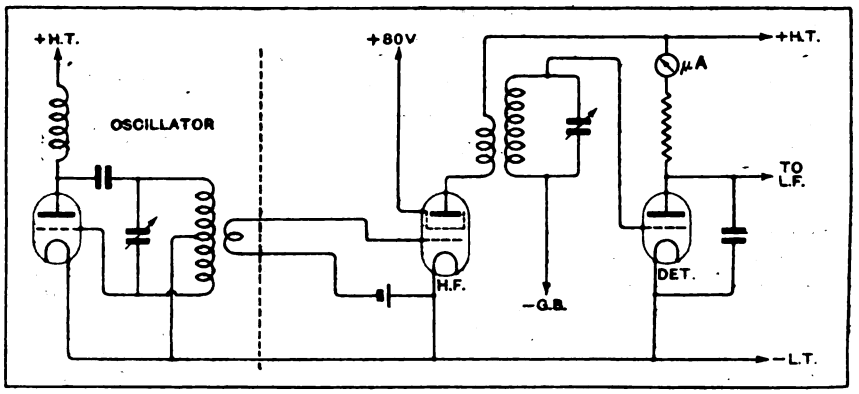

Fig. 2.—The detector as a valve voltmeter: a simple method of comparing H.F. couplings.

H.F. valve grid directly to the high potential end of the circuit, it will be connected to the potentiometer slider.

o o o o

Too Good.

With a view to using the "Kilo-Mag Four" exclusively for frame aerial reception, I propose to wind special medium-wave H.F. transformers of 27/42 Litz wire. My aim, of course, is to increase amplification in order to compensate for the absence of an outside aerial. Is the plan workable? M. M.

It is hardly possible greatly to increase amplification in the way you suggest, as the use of secondary coils of a "goodness" considerably exceeding that of those specified will probably result in instability, provided the optimum number of turns are provided for the primaries.

Generally speaking, there is no point in using a "better" secondary winding than one with, say, sixty-five turns of 9/40 Litz on a 3in. former. Indeed, a transformer with this coil will probably be responsible for more amplification than can easily be handled in a two-stage set, but by choosing windings of perhaps unnecessarily low resistance it is fairly easy to adjust primaries till maximum amplification combined with stability is attained.

o o o o

Atmospherics or Power Circuit Interference?

Lately I have been troubled by "frying" and crackling noises in my loud speaker; these are particularly annoying when the set (a three-valve H.F.-det.-L.F. combination) is tuned to distant transmissions. The trouble is seldom evident when listening to my two nearest stations, and in any case the interference is weakened by detuning; it is completely obviated by disconnecting the aerial.

First-class components were used in building the set, and the terminals of my H.T. and L.T. accumulator batteries are kept clean. It seems that the interference must be due to external causes; is my assumption correct? L. D. M.

From the fact that the noises disappear when the aerial is disconnected, it can safely be assumed that the set and its accessories are free from blame, and, from your description of the symptoms, we think it almost certain that your trouble is due to atmospherics, which have been prevalent during the last few weeks. Of course, it is possible that some of the interference comes from neighbouring power circuits, but noises due to this cause are generally recognisable by their comparative regularity.

o o o o

Preparing for the Regional Transmissions.

Do you consider that a set with four separate tuning controls is impossibly difficult to operate? In this locality (within a few miles of Brookmans Park) it is to be expected that interference will be a serious problem, and I am wondering whether it would be advisable to add a separately tuned aerial circuit to my "2-H.F." receiver, which already has three dials. S. J. S.

If you have thoroughly mastered the operation of your set in its present form there is little reason to fear that the addition of an extra control will make much difference.

There is sometimes a tendency unduly to stress the difficulties of manipulating a multiplicity of tuning dials; in point of fact, when the number of controls is increased beyond one, or, perhaps more correctly, beyond two, any further additions, within reason, have very little effect in complicating operation. This is because a multi-control set must either be calibrated, or else it must be tuned by rotating each dial in turn through a few degrees in such a way that all circuits are maintained more or less in a state of resonance.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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METAL CABINETS.

IN the early days of amateur receiver construction the process of building a set was comparatively simple except when, in the absence of ready-made components such as we have to-day, it became necessary for the amateur to make these parts for himself. The actual assembling of the apparatus was easy, no screening was needed and no special precautions had to be taken with regard to the disposition of the parts; but as time went on, and the efficiency of valves increased, the need for greater care, particularly with regard to the H.F. side, became apparent if interaction between circuits was to be avoided. As valves still further improved in efficiency and the stage gain obtainable with specially designed low-loss H.F. couplings increased by leaps and bounds the amateur began to find that the art of the tinsmith had to be added to his other accomplishments before a modern receiver could be built at home.

The designers of *The Wireless World* sets have been concerned for some time past because of this difficulty in constructing metal screening boxes, and it is realised that for complete screening the home construction of an elaborate metal container is rather beyond the inclination and, perhaps, even the ability of the majority of those who construct experimental sets at home.

"The Wireless World" Design.

Having given very careful consideration to all the problems involved, the *The Wireless World* technical staff has proceeded with the design of metal cabinets on what are believed to be novel lines. A description of the principle of these cabinets, with general details, appeared in our issue of last week, and from this article it will be seen that it is possible to standardise the style of cabinets along these lines. The very great advantage is offered in this type of construction that all components and wiring of the set are readily accessible, wiring being done "on the flat," the main screening box fitting down over the set after the last wire has been connected.

By standardising the size of metal cabinets it should, we believe, be possible for manufacturers to produce them at a price considerably below that at which they could sell cabinets specially constructed for each particular set. So long as an individual form of metal shielding is adopted for every new design of receiver the cost is bound to be high, and only by standardisation can one hope that the price can be reduced and the metal screening cabinet become readily available to the constructor.

* * * *

AMATEUR STATUS.

CORRESPONDENCE which we are receiving from readers indicates very clearly that our editorial notes on the question of the status of the British amateur were timely, and that there is throughout the country a very general feeling that the transmitting amateur is not receiving fair play from the authorities, and that, to a considerable extent, the amateur is himself to blame because he has neglected to hold his own with the Post Office and justify his existence.

We hope that the present opportunity which is given for a frank discussion of the situation may lead to a better understanding between amateurs individually and the various amateur organisations, so that, once again, as in the past, the amateur can show a united front and be in agreement as to the general policy which should be adopted to insure the continued existence of the British transmitting amateur as a factor in radio development in this country.

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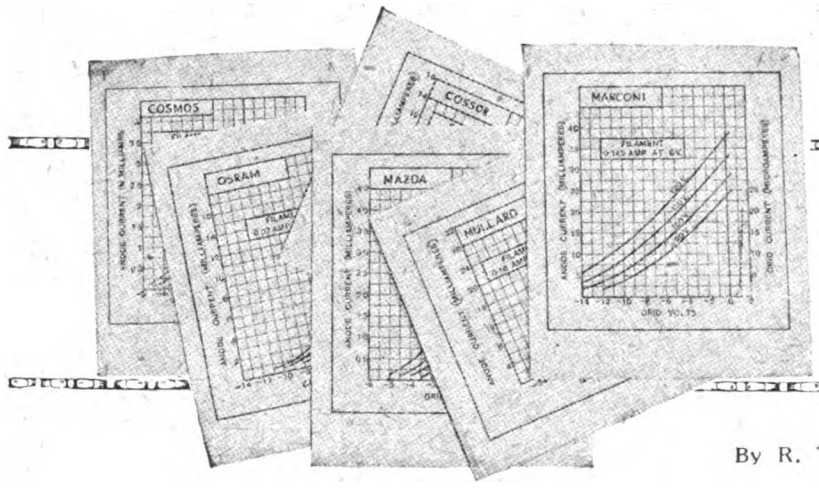

VALVE SELECTING CHARTS

By R. T. BEATTY, M.A., B.E., D.Sc.

A New Classification of Receiving Valves.

OUR modern newspapers supply a neat little weather chart every morning from which Mr. Everyman can, with a little concentration, predict a number of things about the coming day. He can make a fairly reliable estimate of the direction of the wind, the amount of rain fated to descend, and the number of hours during which the sun will shine.

But Mr. Everyman makes no estimates; he knows that just below this ingenious but boring chart the gist of the matter will be revealed in some such phrase as "dry and warm."

He investigates no farther; these two adjectives have settled for him the question of what he will choose for lunch and how he will spend his evening; he has made his daily weather classification. And so we leave him as he turns to the stimulating item of the vanished Park Lane money-lender.

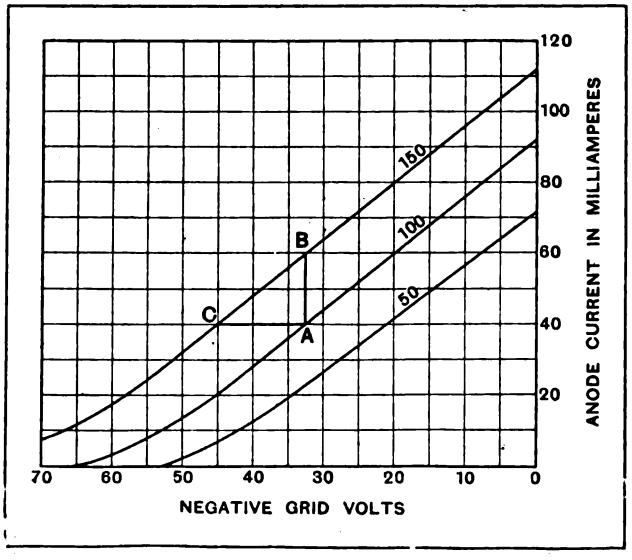

Fig. 1.—Typical valve characteristic curves from which valve A.C. resistance and amplification values can be readily determined.

Valve Charts.

Just as each day has its weather chart so each valve has its set of characteristic curves, published by its manufacturers, and people who are skilled in the study of such curves can deduce from them at a glance the most suitable place for a valve in a receiving set. Thus, in the case of the curves illustrated in Fig. 1 we see that in travelling from A to B the grid bias remains constant, the anode voltage rises by 50, and the plate current by 20 mA.; hence the *differential resistance* (A.C. resistance or impedance, R_0) is $\frac{50 \times 1000}{20} =$ 2,500 ohms, or the figure produced by the change in anode potential divided by the change in anode current in amperes.

Again, in travelling from A to C the plate current remains the same, the grid bias alters by 12.5 volts, and the plate volts alter by 50; hence the *voltage amplification factor* (μ) is $\frac{50}{12.5} = 4$, or the change in anode potential divided by the change of grid bias. It is now evident that we are dealing with a power valve; its resistance of 2,500 ohms will match well with a 2,000-ohm loud speaker, and the plate current is sufficient to give adequate volume to fill a fair-sized room. We may indeed discard the set of curves, since we have extracted from them two essential ingredients.

R—Differential resistance (also called impedance and anode resistance) = 2,500 ohms.

μ—Amplification factor = 4.

Classification of Valves by R and μ.

This result suggests an arrangement of valves according to their values of R and μ, and on Chart I the figures have been plotted in this way on logarithmic paper.[1] In order to avoid crowding the diagram, a selection of typical valves has been made, and these extend in

[1] A somewhat similar classification has recently been made for French valves by D. Deraux, in *L'Onde Electrique*, 1929, p. 38.

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Valve Selecting Charts.—

an irregular procession from the south-west, where the power valves are stationed, to the north-east, the region of screen-grid valves, in which AC/S (R=800,000, μ=1,200) occupies a solitary position.

A number of dotted lines sloping diagonally across the chart is shown, and along each of these the mutual conductance is constant, its value being marked on each line. Most of the members of the procession keep within the two limiting dotted lines.

The Valves are Arranged in Groups.

A little investigation of the chart shows that from head to rear of the procession the valves are arranged in definite groups. As in an army deploying for attack, the regiments advance in succession, so each class of valve has its special location in this procession. The separation of the different classes, however, is not perfectly sharp, and the analogy would be more complete if we consider the troops in the early stages of the actual attack, when obstacles have been met and slight con-

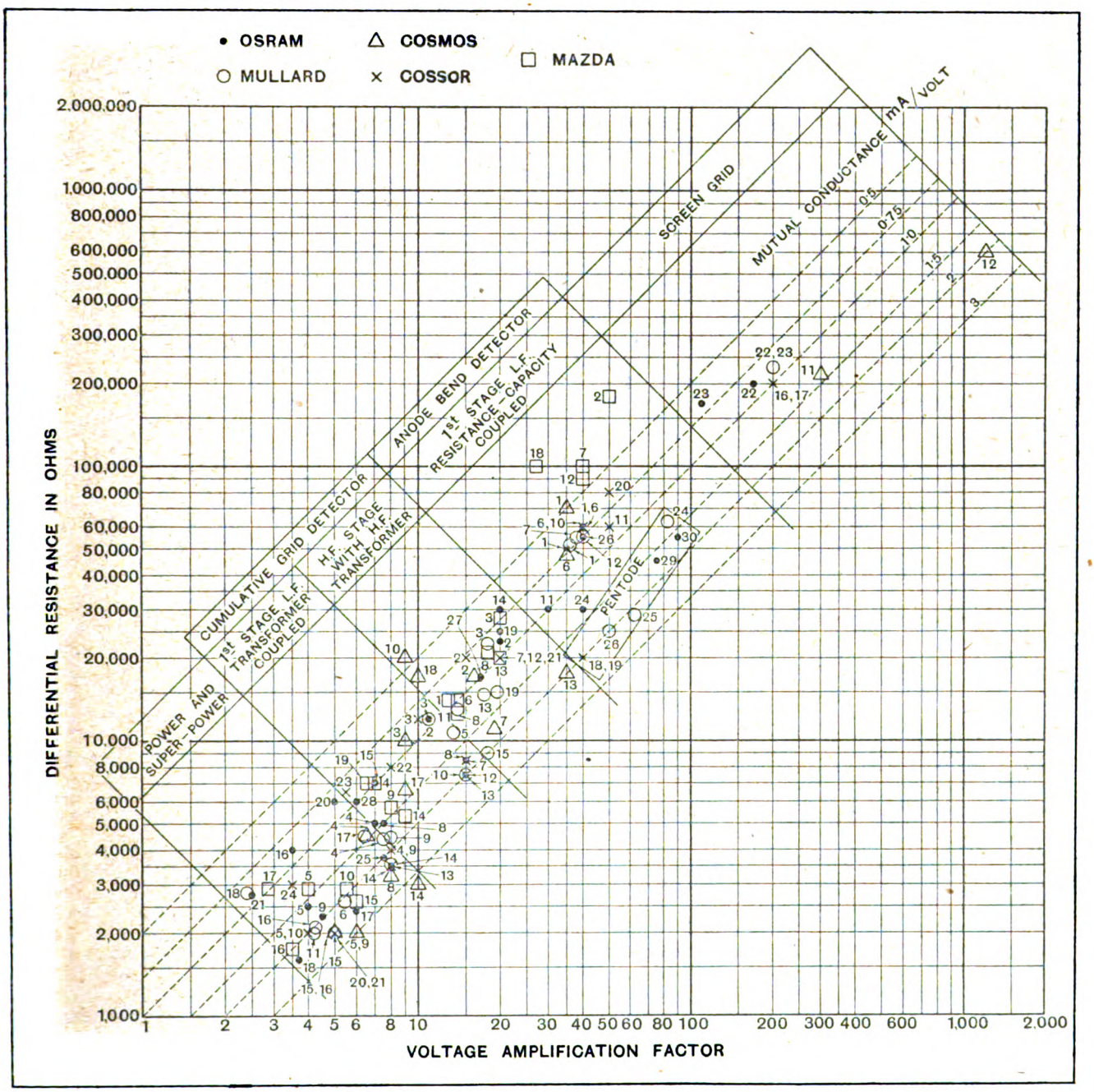

Chart I.—The suitability of a valve for a particular position in a receiver is revealed by finding its location in the centre cross chart by reference to its values of A.C. resistance and amplification factor.

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Valve Selecting Charts.—

fusion has arisen so that men of different regiments find themselves standing side by side.

With this limitation in mind, we may proceed to draw a number of parallel lines running athwart the procession, and so divide it up into a series of groups.

Screen-Grid Valves.—At the head of the procession stand the screen-grid valves; they are remarkable for their extraordinarily high values of resistance and amplification, while their mutual conductance is scarcely inferior to that of a power valve. These valves are eminently fitted for high-frequency amplification with tuned plate coils or high-frequency transformers. The large mutual conductance ensures high amplification, the large resistance has but little shunting action on the plate circuit and so the selectivity is good, and finally the very small capacity between plate and grid confers stability. These valves are definitely separated from their neighbours; they do not spill over into the adjoining compartment.

Anode Bend Detectors.—Next come valves suitable either for anode bend detection or for first stage L.F. amplification with resistance-capacity coupling: they are grouped about a region where $R = 50{,}000$, $\mu = 40$. High amplification is desirable for sensitivity, and in this group it has been pushed as far as is at present possible with triodes. The high valve resistance which obtains in this group is actually undesirable, since it absorbs a considerable amount of the A.C. voltage which should appear across R_1 (Fig. 2): valve designers, however, are unable at present to solve the problem of making μ large and R small simultaneously.

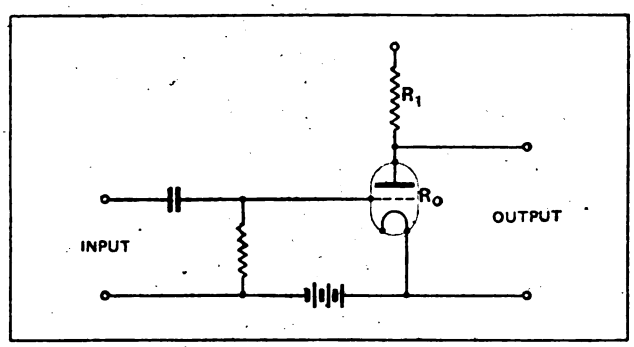

Fig. 2.—Schematic circuit representing an anode bend detector, or with a less value of grid bias a first stage amplifier. The stage amplification is $\frac{\mu R_1}{R_1 + R_0}$, a figure which advances with increase of μ (valve magnification factor) and reduction of R_0 (valve A.C. resistance).

We must not assume, however, that the most suitable valve in this group is one which has the lowest resistance: such a valve will probably pass a large plate current of perhaps 2 mA., which would require 200 volts to drive it through a plate resistance of 100,000 ohms. If a H.T. potential of 150 volts is used probably 120 volts will be absorbed in the resistance, leaving only 30 volts on the plate, under which conditions the valve resistance would be much greater than its normal value.

High-Frequency Amplifying Triodes.—The high-frequency valve occupies a delicate and difficult position. Situated as it usually is between a tuned input system and a tuned plate system, its function is to receive potentials from the former and hand them on with increased intensity to the latter. At the same time it must prevent potentials from leaking back in the reverse direction: if it fails in this duty these two highly resonant systems will fall foul of each other and uncontrollable oscillation will result.

KEY LIST OF VALVES.

	OSRAM. ●	MULLARD. ○	COSMOS. △	COSSOR. ×	MAZDA. □
1	DEH 210	PM 1A	SP 16 B	210 RC	GP 210
2	HL 210	PM 1 LF	SP 16 G	210 HF	RC 210
3	DEL 210	PM 1 HF	SP 16 R	210 LF	HF 210
4	DEP 215	PM 2	SP 18 RR	220 P	LF 215
5	DEP 240	PM 2 DX	SP 280 PI	230 XP	P 227
6	DEH 410	PM 252	SP 610 B	410 RC	GP 407
7	DEL 410	PM 3 A	SP 610 G	410 HF	RC 407
8	DEP 410	PM 3	SP 610 RR	410 LF	HF 407
9	P 425	PM 4	SP 625 P	410 P	LF 407
10	DEH 610	PM 4 DX	DE 50	415 XP	P 415
11	HL 610	PM 254	SP 215 S	610 RC	GP 607
12	DEL 610	PM 5 B	AC/S	610 HF	RC 607
13	DEP 610	PM 5 X	AC G	610 LF	HF 607
14	DE 5 B	PM 6	AC/R	610 P	LF 607
15	DE 5	PM 6 D	AC/PI	610 XP	P 615
16	DE 5 A	PM 256	AC/P2	220 SG	PX 650
17	P 625	DFA 6	AC/227	410 SG	B 12
18	P 625 A	DFA 7	AC/X	230 PT	Two-stage valve.
19	LS 5 B	DFA 8		415 PT	TS 215
20	LS 5	DFA 9		M 41 RC	
21	LS 5 A	DO 20		M 41 HF	
22	S 215	PM 12		M 41 LF	
23	S 625	PM 14		M 41 P	
24	KH 1	PM 22		M 41 XP	
25	KL 1	PM 24			
26	H 8	PM 26			
27	HL 8				
28	P 8				
29	PT 0.8				
30	PT 235				

The maximum stage gain from grid to plate can only be obtained by co-operation between the valve and the tuned plate circuit. With triodes a neutralised step-up transformer is required, and it can be shown[2] that the best step-up ratio from primary to secondary is given by the formula:—

Square of turns ratio = parallel resistance of secondary circuit divided by valve resistance,

$$\text{or } n^2 = \frac{R_2}{R_0}$$

where n is the turns ratio, R_2 the resistance at resonance, and R_0 the differential or A.C. resistance of the valve.

When the transformer is thus designed to suit the valve resistance the stage gain is:—

half the valve amplification × turns ratio[3]

$$\text{or } A = \frac{\mu}{2} \times n$$

[2] McLachlan, *Experimental Wireless*, 1927, p. 599; Harmon, *The Wireless World*, Vol. 22, 1928, p. 144.

[3] Harmon, *The Wireless World*, Vol. 22, 1928, p. 144.

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Valve Selecting Charts.—

$$\text{or } A = \frac{\mu}{2} \times \sqrt{\frac{R_2}{R_0}}$$

Thus a change of valve will leave the stage gain unaltered, provided $\frac{\mu}{\sqrt{R_0}}$ remains the same: this quantity, the magnification factor of the valve, divided by the square root of its A.C. resistance, may be regarded as a figure of merit of the valve as regards its amplifying power. R_2 may easily attain a value of 160,000 ohms at broadcast frequencies with a solid wire coil wound on a 3in. former and a stage gain of 30 can be then obtained if $\frac{\mu}{2}\sqrt{\frac{160{,}000}{R_0}} = 30$, or $\frac{\mu}{\sqrt{R_0}} = \frac{3}{20}$.

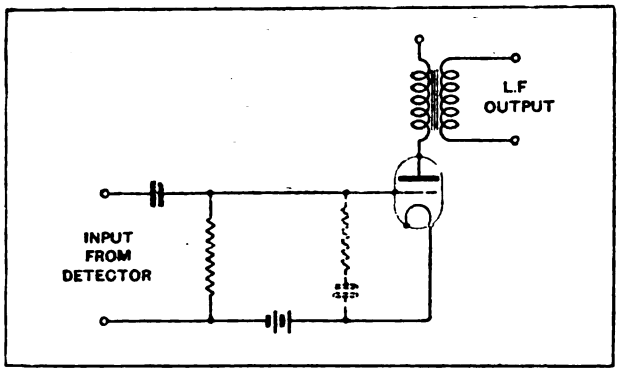

Fig. 3.—A first stage L.F. amplifier followed by a transformer coupling. The transformer load is transferred back through the grid-plate capacity and appears as an input impedance as shown in dotted lines. This impedance shunts the grid leak at high audio frequencies when μ is too large.

This relation between μ and R_0 would appear as a straight line on the chart joining the points A=90,000, μ=45, and R=10,000, μ=15. If the reader will draw this line, which corresponds to a stage gain of 30, he will see that a number of valves lie in its vicinity, both in the anode bend compartment and the H.F. compartment, and even among the power valves, so that at first sight it would seem that a wide range of triodes is available for H.F. amplification.

But this range is narrowed down by the necessity for stability, which becomes more insecure as μ increases. If the triode is used without a neutralising circuit stability cannot be obtained anywhere along this line, and even with a neutralising circuit the balance is not perfect over the whole tuning range, and it is found by experience that it is unwise to allow μ to exceed 30. This limits the upper range. The lower range is also limited by the fact that with triodes of small impedance the plate current is unnecessarily large. Accordingly, the useful H.F. triodes are actually contained within the compartment assigned to them on the chart.

First Stage L.F.-Transformer Coupled.—In this type of circuit the valve is followed by an iron-cored transformer which, if of mediocre quality, may have a primary inductance not exceeding 30 henrys. At 50 cycles the reactance of such a primary winding is $2\pi \times 50 \times 30$, say 10,000 ohms, and if the valve resistance exceeds this value considerably, the low notes will be attenuated.

A large value of μ would result in large amplification, but here again a limiting condition occurs. The transformer load is transferred back through the internal grid-plate capacity, and appears as an input impedance between grid and filament (Fig. 3). At the higher audio-frequencies this input impedance consists of a resistance in series with a capacity, and its effect is to attenuate appreciably the high notes coming from the detector if μ is allowed to rise much above 10.[1]

Power Valves.—These bring up the rear of the procession: they are characterised by low A.C. resistance and large mutual conductance. On the chart the power and super-power valves are jumbled together, since the values of plate current and plate voltage have not been incorporated.

These valves can be better exhibited as in Chart 2, where they are located according to plate current and

[1] McLachlan, *The Wireless World*, Vol. 22, 1928, p. 465.

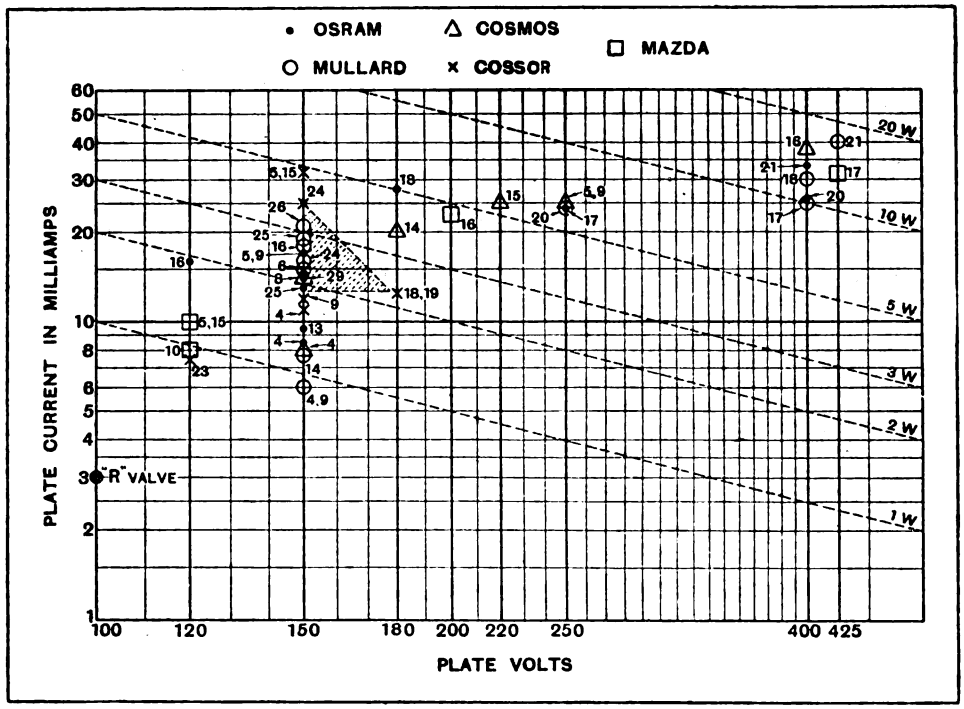

Chart 2.—Power valves classified according to anode current and voltage.

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Valve Selecting Charts.—

voltage. The dotted lines crossing the diagram are lines of constant power dissipation at the plate, and valves lying above the 5-watt line may be considered as super power. The power ranges from 17 watts downwards, while right at the bottom is the War-time "R" valve, which at that time ranked as a power valve with a consumption of 0.3 watt!

The pentodes occupy an anomalous position on the chart: they lie within the shaded region at an average level of 3 watts plate dissipation, and so would appear to be excluded from the super-power series. But, owing to the peculiar shape of their characteristic curves, the fraction of this power which they can deliver to the loud speaker without distortion is about 2½ times as great as in the case of triodes, so that really they belong to the 7.5 watt level and attain to super-power rank.

General Survey of Chart 1.—Reverting to Chart 1, we see that the procession of *triodes* does not march parallel to the dotted lines, but that as the head is approached there is a distinct tendency to move into regions of smaller mutual conductance. This regrettable feature is an inherent property of triodes: as μ is increased the mutual conductance tends to decrease.

But the advent of the tetraodes (screen grid) and pentodes has straightened out the line of march. The new valves have been brought in to redress the balance of the old. Remove the plate from a tetrode and a triode remains with practically the same mutual conductance, but with a μ of about 7. Replace the plate and the valve, keeping on the same dotted line, moves up to the front, with a μ of, say, 200. The fourth electrode was introduced to diminish the plate-grid capacity and so confer stability on H.F. circuits, but as an almost accidental result the value of R rose to about 200,000 ohms, giving the additional benefit of increased selectivity.

Again, the basis of the pentode is a power valve with, say, μ of 5 and mutual conductance of 2. Add an extra electrode and it moves along its dotted line into the pentode region, but possesses a nasty kink in its characteristic curves which interferes with its use as a power valve. Add a second additional electrode and the kink disappears, and the characteristics take such a shape that the pentode can deliver two and a half times as much power as the triode from which it sprang.

FADING VARIATIONS.

Fluctuations in signal strength caused by fading are usually troublesome in long-distance working, but are particularly so in the case of picture transmission. From time to time various suggestions have been made with the object of securing an automatic regulation or volume control which will render reception independent of the fluctuating attenuation of the ether. One such method is to transmit a special "control" impulse of a frequency lying outside the band of signal frequencies. In reception this is utilised to adjust the amplification factor of the receiving valves, preferably by automatically varying the initial grid bias of the first stage of amplification. When fading is strongly in evidence the initial valve amplifier of the receiver is in this way made more sensitive, and vice versa.

A single "control" frequency does not, however, invariably compensate for the particular type of fading caused by interference between the space-wave and earthbound components of the main signal energy. In order to overcome this deficiency it has recently been proposed to modulate the "control" impulse or note so that the latter comprises a "complex" of frequencies all lying outside the main signalling band. The control of the receiver is then continuously effective, since the current input used to adjust the initial grid bias is the average value of a sinusoidal wave and never sinks to zero. (Patent No. 298,463.)

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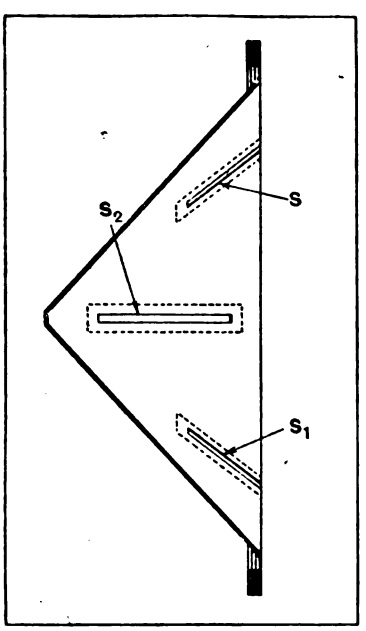
LOUD SPEAKER CONES.

Excellent reproduction over a wide-frequency range, with a particularly favourable response to the lower notes, is stated to be the result of cutting a series of radial slots in a conical diaphragm. The method is due to S. G. Brown, F.R.S. (Patent No. 301638), and is illustrated in the figure, where short slots S, S_1 are shown extending from the edge inwards, whilst a longer slot S_2 is cut intermediately.



Radial slots with tissue paper covering to improve the behaviour of a loud speaker diaphragm.

The favourable action is due to the fact that the existence of the slots adds to the flexibility of the diaphragm, and at the same time allows a certain amount of circumferential expansion under the influence of low-frequency vibrations. The slots are preferably covered over by strips of thin tissue paper or other flexible covering, so as to prevent the setting-up of undesirable short air paths between the back and front of the diaphragm.

PATENT NOVELTIES.

Books and Catalogues Received.

Messrs. Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1. — Illustrated leaflets of "Magnum" components and descriptive folders dealing with portable, trasportable, and "Universal Three" receivers.

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A.E.G. Electric Co., Ltd., 131, Victoria Street, London, S.W.1.—Illustrated leaflets of A.E.G. double-scale moving-coil voltmeters.

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Messrs. A. C. Cossor, Ltd., Cossor House, Highbury Grove, London, N.5.—Illustrated folder describing the Cossor Pentode. Also "The Cossor Wireless Book," devoting 64 pages to the "Cossor Melody Maker."

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Messrs. C. A. Vandervell and Co., Ltd., Acton, London, W.3.—Price list of C.A.V. accumulators.

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International Convention for the Safety of Life at Sea.—Signed at London, May 31st, 1929. Issued by the Board of Trade, London. In English and French. Pp. 119 (double). Published by H.M. Stationery Office. Price 4s. net.

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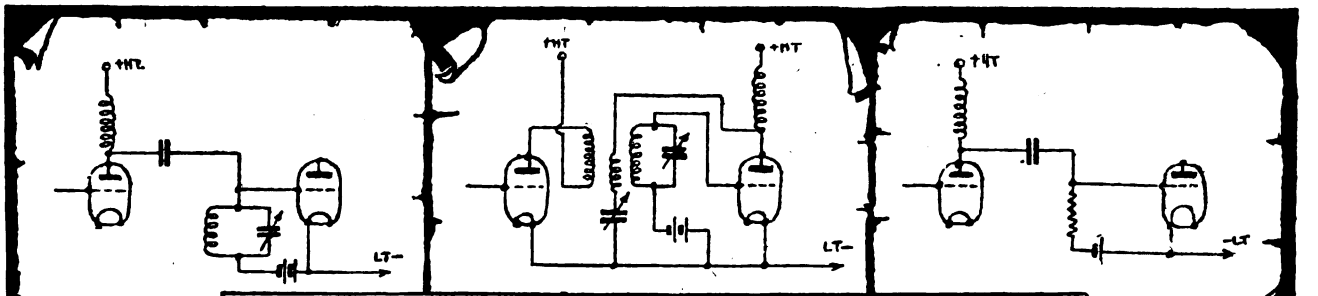

The DESIGN of H.F. CHOKES

Method of Testing H.F. Chokes to Ensure Maximum Efficiency.[1]

SINCE the very earliest days of radio telegraphy, H.F. choke coils have played an important part in both transmitter and receiver circuits. It is with regard to the latter application that these notes have been written, and attention will naturally be focused on the modern uses of such coils. It will be as well, perhaps, to remember that a "choking coil" of any kind is an A.C. electrical device which will offer a high impedance to the passage of electrical energy when A.C. voltages are applied to it at the frequency or range of frequencies for which it is designed. Such a device must of necessity offer a comparatively low resistance to direct currents.

H.F. choke coils which are to be suitable for *all* the circuit arrangements to be found in modern radio receivers must, however, possess an additional property which is of the utmost importance in certain circumstances. This property is that the coil must show practically no sign whatsoever of "energy absorption" when voltages are applied to it at the wavelength or frequency bands for which it is to be used. It is a comparatively simple matter to design a choke coil which will give very low "absorption" over a small band of wavelengths such as 200-400 metres, and which will at the same time maintain an effective impedance of high order. When the waveband, however, is extended to cover, say, 200-2,000 metres, the problem becomes more difficult and requires careful experimental work for successful solution. Part of a circuit arrangement in a typical modern radio receiver calling for this special design of H.F. choke is shown in Fig. 1. The screen-grid valve has this H.F. choke in its main anode circuit, and the H.F. voltages developed across it will be almost identical with the voltages across the following tuned-grid circuit, which is virtually in parallel with the choke. The operation of this arrangement may seem somewhat obscure at first sight, but may be satisfactorily explained as follows: When H.F. voltages at any one frequency are applied to the grid filament circuit of the screen-grid valve, practically zero H.F. voltage will exist over the H.F. choke and the following grid circuit, unless the circuit is tuned to the frequency being used. This is due to the second grid circuit acting as a complete "damper" to the first anode circuit or H.F. choke, the H.F. choke here having an impedance which, even with badly designed chokes, is far higher than that of the non-resonant following circuit. Tuning this second grid circuit to resonance, however, will restore the high effective anode impedance required, *provided that the H.F. choke itself does not show any signs of absorption at this frequency.*

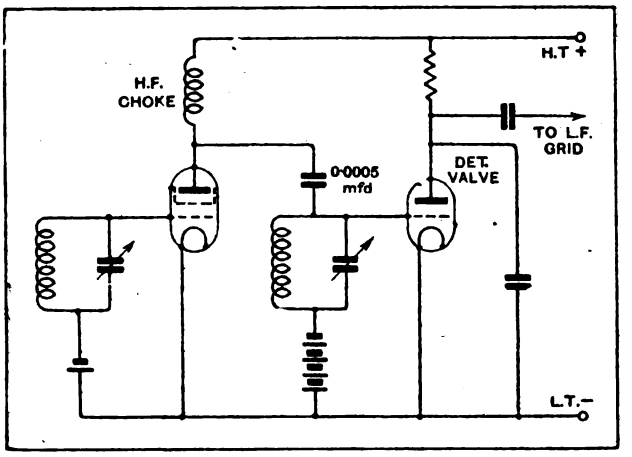

Fig. 1.—Typical parallel-feed coupling for a screen-grid H.F. amplifier.

Testing Circuit.

Fig. 2 shows a simple arrangement which is suitable for giving careful "absorption" tests on various types of H.F. chokes. The essential features are:—

(1) A low-loss screened variable air condenser.

(2) Calibrated valve voltmeter.

(3) Non-reactive radio frequency variable resistance box. (Constant with change of frequency.)

(4) Typical receiver tuned circuit coils.

(5) Calibrated C.W. wavemeter.

The double-pole double-throw switch will parallel any H.F. choke under test with the resonant tuned circuit, which is energised by the C.W. wavemeter. The single-

[1] Contributed by the Research Staff of R.I., Ltd.

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The Design of H.F. Chokes.—

pole double-throw switch is used for short-circuiting the resistance box. The general method of operation is to set the C.W. wavemeter to generate at the wavelength required, then connect the H.F. choke under test to the double-pole double-throw switch and set this switch to "choke out." Short circuit resistance box by means of single-pole double-throw switch and couple the wavemeter loosely with the tuning coil suitable for the wavelength. Adjust the condenser very carefully to give maximum resonant voltage across the tuned circuit; in the test results given here, a voltage of approximately 2 was adhered to throughout (V_1). Note the variable air condenser reading (C_1) and then set the double-pole double-throw switch to "choke in"; retune the circuit to resonance and read C_2 and V_2 *without changing the wavemeter coupling*. For a band of wavelengths, therefore, a curve may be drawn showing 100 V_2/V_1 (percentage of original voltage upon inserting choke in parallel) as ordinates, against wavelength as abscissæ. The tests should be performed with great care at as many wavelengths within the band as is practicable, otherwise "absorption" points will not be revealed. If absorption is suspected close to any one or more wavelengths it will be wise to explore closely around these wavelengths to obtain the true curve shape.

A measure of the "inserted series resistance" effect of the choke on the tuned circuit may be readily followed at any one or all of the test wavelengths by opening the single-pole double-throw switch and setting the resistance box to read, say, 3 ohms for short-wave tests, or, say, 10 ohms for long-wave tests; then repeat the test as before, and, after reading V_2, *reduce* the resistance box to some reading which will increase V_2 to give the original voltage V_1 *without any change of coupling*. It may be necessary here to retune slightly. Both the value of the percentage of original resonant voltage and "inserted series resistance" depend greatly upon the effective resistance of the tuning coils used for the tests, so that typical moderate or low-loss coils must be used.

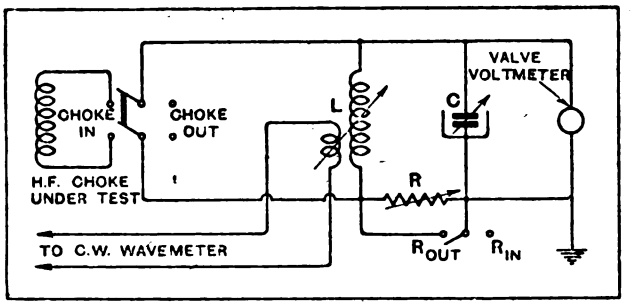

Fig. 2.—Schematic circuit diagram of apparatus used in taking the curves shown in Fig. 3.

The effective capacity of the choke may be obtained directly either as a positive or negative value by calculating the difference between condenser readings C_1 and C_2 for any given wavelength. When C_2 is less than C_1, the choke is acting as a resultant condenser; when C_2 is greater than C_1, it is acting as a resultant inductance; when C_2 exactly equals C_1, the choke is completely non-reactive at this wavelength. Nearly all of the commercial types of H.F. chokes for use between 200 and 2,000 metres, tested under these conditions, show absorption on the short-wave band, some to such a degree on one or more particular wavelengths rendering the choke completely useless for the "choke anode feed followed by coupled tuned-grid circuit" method of H.F. amplification. Careful experiments performed showed the desirability of producing a choke having an actual total self-inductance somewhat lower than that of many commercial types, but with individual section inductances of moderately high order.

The final design (dual astatic type) found the best

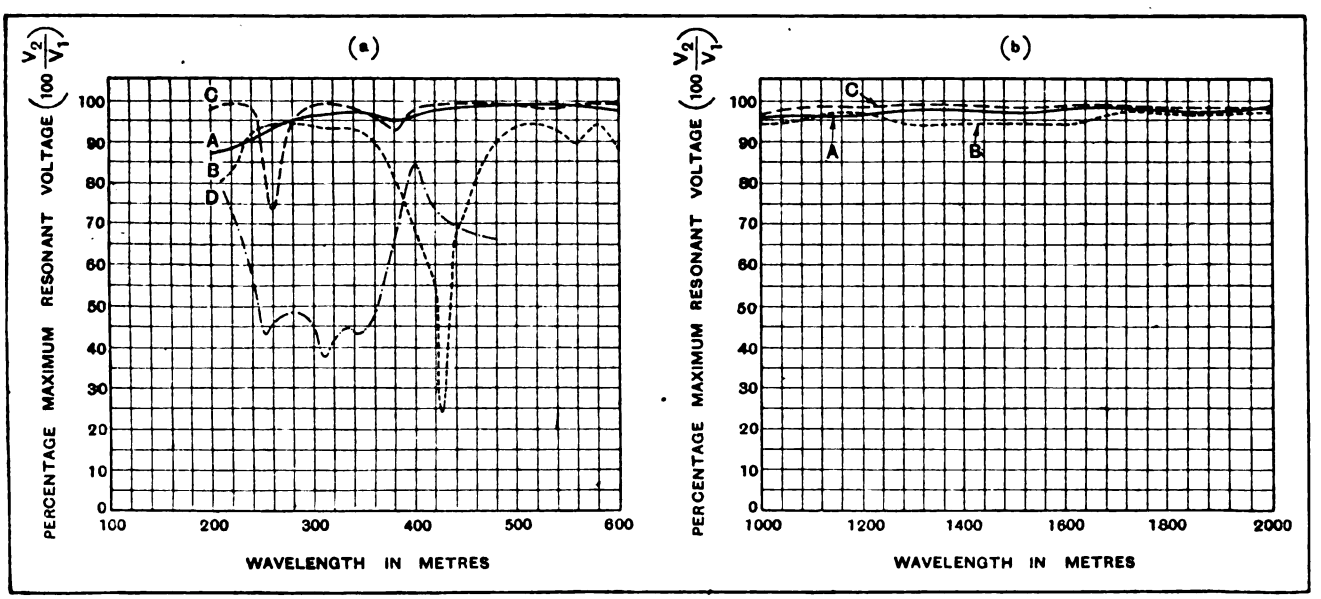

Fig. 3 (a) and 3 (b).—Absorption curves of some representative chokes taken under conditions equivalent to the circuit of Fig. 1. Choke A in each case is of the dual astatic type; chokes B, C and D are non-astatic.

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The Design of H.F. Chokes.—

for the wavebands 200-600 metres and 1,000-2,000 metres, gave the curve shown by the thick line A. Other types (both experimental and commercial) gave curves marked B, C, etc. The absorption wavelengths as shown by these curves are very marked indeed for some types of H.F. chokes, so much in some cases that at their particular absorption wavelengths the chokes concerned are likely to give very serious trouble when used in the circuit mentioned previously.

Internal resonances are responsible for these serious faults in H.F. chokes, and practically nothing can be done to improve them except a radical alteration in design. A small or moderate change in turns will give a slight shifting of the absorption points, but is usually quite ineffective as regards complete elimination of them. The curves for 1,000-2,000 metres show that there is no difficulty in design as regards this section of the broadcast bands. It was found that with the majority of H.F. chokes tested, freedom from absorption could be seriously lowered by the proximity of metallic screens. Thus it would appear definitely desirable that H.F. chokes should be wound astatically in order that these screening effects should be reduced to a minimum and to avoid interaction effects between H.F. chokes and associated tuned circuits.

Cases in which H.F. chokes are used in the anode circuits of detector valves are of less importance, due possibly to the ease with which the operating conditions may be varied. The usual function of a choke in this position is to act purely as a barrier to H.F. components or currents present in the anode output circuits of these valves.

Chokes as H.F. Barriers.

This is necessary both for the satisfactory operation of reaction devices and to prevent the amplification of high- or radio-frequency currents by the L.F. section of the receivers. Energy absorption by a choke when used in this position may exercise a marked effect upon the apparent selectivity of the receiver when the reaction coupling is advanced to just below the oscillation point. The selectivity appears to become much worse rather than better as the reaction coupling is increased. In cases where capacity controlled reaction is used, any increase of the capacity whilst increasing the reaction coupling will obviously introduce the H.F. choke losses into the tuned circuit and give flatness of tuning with poor selectivity.

It is thought that these notes will be of great assistance to the designers of radio receivers, in view of the increasing popularity of the H.F. choke parallel anode feed system for S.G. valves, the advantages of which are becoming increasingly well known.

MODES OF APPLYING REACTION.

DESPITE recent advances in high-frequency amplification, it is probably true to say that the vast majority of receivers in use to-day employ reaction as the chief aid to long-distance reception, for it is still not uncommon for an H.F. valve to be little better than a passenger. The consideration of the most convenient mode of applying reaction is therefore a matter of interest to a very large number of listeners.

The favourite method a year or two ago, when plug-in coils were in vogue, was to connect a reaction coil, which could be variably coupled to the aerial coil, directly in the plate circuit of the detector valve. Even though a geared coil-holder was employed, this method was never very satisfactory, the chief reason for this being that the proximity of the reaction coil upset the tuning to such a degree that extensive retuning was necessary after every alteration in reaction coupling. The interdependence of the two controls made the tuning-in of a distant station an unnecessarily troublesome process.

Reinartz Reaction Difficulties.

The Reinartz circuit offered an improvement in this direction, but in its original form in which the reaction coil was wound as a continuation of the tuning coil and the reaction condenser was connected between the end of this coil and the plate of the valve, another difficulty made its appearance. This was due to the fact that both sides of the reaction condenser were at a high-frequency potential relative to earth, so that hand-capacity effects were liable to be very marked. Metal panels and other forms of screening are not very helpful in this connection, because in any normal case the spindle of the condenser is metallically connected to the moving plates, and as the spindle has to project through the panel for control purposes the screening is necessarily imperfect.

Later modifications of the Reinartz circuit have done away with this difficulty by connecting the reaction coil direct to the plate of the valve, and interposing the reaction condenser between this coil and earth, so that provided the moving plates of the latter are joined to earth, a metal-lined panel can be used to remove any lingering traces of hand-capacity effects.

If this type of circuit, which is perhaps the most satisfactory of all, be adopted, it is found that the tuning can be made sufficiently independent of the reaction control to make adjustment of the receiver easy, though it is usual for the setting of the reaction condenser to vary widely over the different parts of the tuning range. This, however, is not found to make tuning difficult, and so is of but little practical importance.

It is found in practice that the greatest degree of independence between the controls is attained when the reaction condenser is not too small. It is therefore easier to handle a receiver in which the reaction coil is small, or loosely coupled to the tuned circuit, but is fed through a condenser of maximum capacity, perhaps 0.0003 or 0.0005 mfd, than one in which the same degree of reaction is obtained by the use of quite a small condenser in conjunction with a large coil.

The remarks here made are equally applicable to receivers in which a stage of high-frequency amplification precedes the detector, even although in this case critical reaction should be required less frequently, and is, in fact, often dispensed with altogether.

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ONE PIRATE PER ROAD.

At the Brentford Police Court last week an official of the Richmond Postal Staff stated that one unlicensed wireless set was found on the average in each road.

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TWIN-WAVE TRANSMISSION FROM SPAIN.

The Barcelona (EAJI) station proposes to erect a short-wave transmitter on the summit of Monte Tibidabo, in close proximity to the present aerial, with the object of transmitting programmes simultaneously on medium and short wavelengths.

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HOSPITAL ASKS FOR HEADPHONES.

An appeal for 150 pairs of headphones is being issued by the Selly Oak Hospital, Birmingham. The Hospital Committee believes that there must be many pairs of discarded headphones throughout the country owing to the advent of the loud speaker.

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TRAIN WIRELESS DIFFICULTIES.

The Paris-Orleans Railway has temporarily abandoned the idea of establishing a regular service of broadcast reception on express trains. Experiments have been conducted at intervals ever since 1923, but it is realised that atmospherics and other extraneous noises have still to be conquered before a reliable service is possible. The company's engineers contend that their aims will only be achieved when the French broadcasting stations create a strong enough field strength to "smother the parasites."

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THE MULTIPLE CONDENSER PATENT.

A mild sensation has occurred in the American radio industry due to a notice received by the leading firms claiming that they are infringing a basic patent recently granted by the U.S. Patent Office. The patent, bearing the name of Walter S. Lemmon, is held by Radio Industries, Inc., and covers the multiple condenser, tuned by "gang control."

Companies which have received warning notices include Kolster, Radio Corporation of America, Bosch, Grigsby-Grunow, Zenith, and Stromberg-Carlson.

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SUNDAY CONCERTS FROM HOLLAND.

Listeners in Britain continue to express their appreciation of the Sunday evening broadcasts from Hilversum arranged by Kolster-Brandes, Ltd. The next concert will be given on July 28th at 5.40 p.m., when selections will be played by Hugo de Groot's orchestra. Hilversum's wavelength is 1,875 metres.

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BUYING BY BEAM.

A bid by beam wireless from South Africa secured one of the lots auctioned last week at Blyth, Northumberland, property sale.

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TILL WINTER COMES.

As the holiday months in Paris and the consequent closing down of theatres brings about a dearth of broadcast artists, *Radio Vitus* has decided to suspend its transmissions until October next, when the station will increase its power.

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MEDALS FOR BRAIN WAVES.

The Fifth International Exhibition of Inventions will open on October 2nd at the Central Hall, Westminster. As in previous years, in addition to the trade exhibits, there will be a New Inventions Section. Gold, silver and bronze medals will be competed for.

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THE LUNCH KIT PORTABLE.

A contributor to our esteemed American contemporary, Q.S.T., has discovered that a metal case of the kind used for lunch kits makes an excellent container for a portable set. The compartments provided for plates, bottles, etc., are used for shielding purposes.

WAVELENGTH SHUFFLING IN HOLLAND.

Severe criticism from listeners in Holland has been levelled at a decree made by the Netherlands Government authorising the Dutch broadcasting stations to exchange wavelengths at different times of the day. Under the decree, which came into operation as from Monday last, July 15, the wavelengths are allocated as follows: 1,875 metres: Hilversum, between 10.20 a.m. and 0.20 B.S.T.; 1,070 metres: Scheveningen-Haven, between 10.20 a.m. and 18,00 B.S.T.; 1,070 metres: Huizen, between 18.20 and 0.20 B.S.T.; 298 metres: Huizen, between 10.20 and 18.00 B.S.T.

On October 6 next, although the same wavelengths are to be utilised, the stations will effect an exchange, and Hilversum and Huizen will take each other's present position. It is proposed to carry out this alteration every three months.

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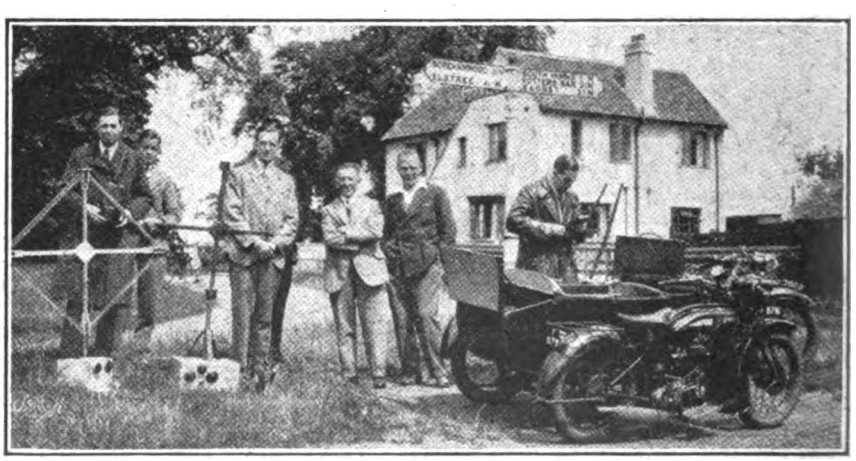
MAINTAINING VALVE PRICES.

In the Chancery Division on July 2nd Mr. Justice Clauson pronounced an injunction in the adjourned case of A. C. Cossor and Co., Ltd., and Richard William Bullimore, against The Gas Light Fittings Co., Ltd., of East Ham, for breach of the Limited Licence for the sale of radio valves manufactured by members of the British Radio Valve Manufacturers' Association. His Lordship



NEW D.F. TEST. The more usual procedure of tracking a concealed transmitter was reversed by the North Middlesex Radio Society recently, when parties with direction-finders, seen above, made unsuccessful attempts to get out of range of a 5-watt transmitter near Ridge, Herts. Two of the receivers shown follow the design of those described by Mr. R. L. Smith-Rose in our issues of August 15th and 29th, 1928.

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granted costs against the defendants, and it was agreed that the exact terms of the injunction should be settled by counsel between the parties.

°°°°

MR. S. R. MULLARD.

We learn that Mr. S. R. Mullard is about to relinquish his position as managing director of the well-known companies bearing his name, in order to devote more of his time to other interests. Mr. Mullard will retain his office as chairman of The Mullard Wireless Service Co., Ltd., and director of The Mullard Radio Valve Co., Ltd., and will be general adviser to the companies.

°°°°

'PHONE SETS FOR OWNER-PILOTS.

A lightweight wireless telephone set for use on light aeroplanes has been designed by the Marconi Company to enable owner-pilots and clubmen to communicate while in flight with ground stations, as is done by commercial passenger-carrying aircraft.

The weight of the new set, known as the Marconi Type A.D.22, has been reduced to about 60lb. It combines a 75-watt telephone transmitter and receiver in a wooden box measuring only 15in. by 9in. by 7in., and the total weight includes complete equipment with all accessories, such as the microphone and telephones, wind-driven generator and accumulator.

A NEW RANGE OF DRY METAL RECTIFIERS.

Interesting Voltage-Doubling Circuit Described.

WESTINGHOUSE copper-oxide rectifiers have become extremely popular both for eliminators and for trickle-charging H.T. and L.T. accumulators from A.C. mains. The H.T.1 unit, already well known to readers and capable of giving a D.C. output of 100 mA. at 200 volts, has been reduced in price to 75s., whilst for those who require a rectifier with the more modest output of 120 volts 20 mA., a new half-wave unit known as the H.T.3 has been introduced selling at 21s.

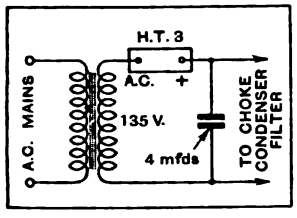
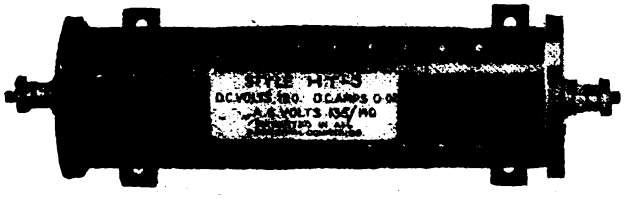


Fig. 1.—How to connect the H.T.3 half-wave unit when used as a rectifier in an H.T. eliminator. The transformer secondary must not develop more than 135 volts under working conditions and a 4-mfd. condenser must be connected directly across the output as shown.

It is interesting to note that the human ear when listening to the average loud speaker can tolerate about four times the superimposed ripple voltage from half-wave rectification as compared with that from full-wave. It is thus possible to employ rather less ambitious smoothing equipment with the H.T.3 than the theory of condenser and choke reactances would dictate. This new rectifier is connected as shown in Fig. 1. When D.C. supply mains are used for charging H.T. accumulators, should the supply fail, or should the main switch be opened, the battery will discharge through all lamps or apparatus that happen to be left connected in parallel with the mains. As an effective non-return valve in these circumstances, the H.T.3 rectifier can be put in circuit as shown in Fig. 2. Its forward resistance is small compared with the limiting resistance, but its reverse resistance is sufficiently high to make the flow-back of current negligible. The charging current should not be allowed to exceed 50 mA.



The H.T.3 unit which embodies a half-wave rectifier.

It has been usual hitherto to connect four metal rectifiers in bridge formation for full-wave rectification, but a voltage-doubling circuit has been introduced with the new rectifier—called the H.T.4—which is capable of giving the same type of output at a considerably reduced cost. It comprises

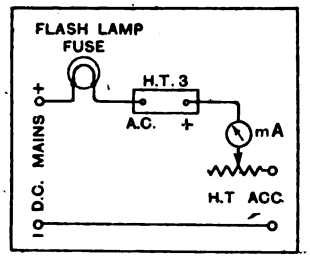


Fig. 2.—The Westinghouse H.T. rectifier used as a non-return valve in a circuit for charging H.T. accumulators from D.C. mains.

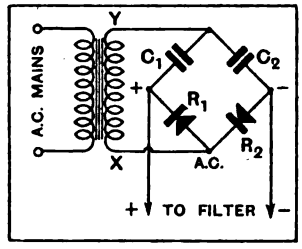


Fig. 3.—The voltage-doubling circuit using a bridge network of condensers and R_1,R_2, which together form the H.T.4 unit. The D.C. voltage on no load will be double the A.C. voltage across XY.

a bridge network having only two rectifier units together with two 4-mfd. condensers linked as in Fig. 3. Not only is full-wave rectification obtained, but the D.C. voltage developed on no load will be approximately double that of the A.C. voltage applied to the bridge network. This voltage "step-up" is independent of the transformer, which must be designed with a secondary to give 135 volts under working conditions, and not more than 140 volts on open circuit.

The doubling circuit (Fig. 3) functions as follows: When X is momentarily positive, current flows through R_1 to + and into the condenser C_1, which will charge up to the peak value of the A.C. voltage across XY. The peak value of a sine wave A.C. voltage is $\sqrt{2} \times$ R.M.S. volts, which become in this case $1.414 \times 135 = 191$ volts. The current which passes to the D.C. load circuit will return to lead Y through C_2, which will have been charged to peak value in the previous half-cycle in such a direction that it will assist the return flow of current; in fact, the transformer voltage and the voltage of the charge in condenser C_2 will be in series in driving current round the load circuit. On the other half-cycle, when lead Y is positive, current passes out to the load circuit from the stored energy in C_1 in series with the transformer secondary and returns to X through rectifier R_2, the voltage of the transformer and the stored voltage in C_1 again being added in series.

The H.T.4 rectifier to be used in conjunction with a bridge network giving a step-up of voltage.

Thus, not only is a step-up introduced irrespective of the transformer, but full-wave rectification is achieved, using only two rectifier units instead of the usual four. The condensers should be of the variety tested at 500 volts. The third terminal on the H.T.4 unit marked A.C. should be connected to the lead X in Fig. 3. For power valves the output to be derived from an eliminator embodying the H.T.4 is adequate, being about 30 mA. at 180 volts.

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Broadcast Receivers

McMICHAEL SUPER RANGE PORTABLE FOUR

A Suitcase Portable of Outstanding Merit.

WHEN regarded from the standpoint of general layout, portable receivers fall naturally into two main groups, (1) the cabinet portable, played as carried in a vertical position; (2) the suitcase portable, carried vertically and operated horizontally with the lid open. For compactness and convenience of handling the latter type undoubtedly takes first place, but it has hitherto found difficulty in competing with the cabinet portable on the score of range and quality owing to the limitations imposed on the layout of the circuit and the size and weight of the batteries by the suitcase construction. Recognition of these facts is essential to a full appreciation of the merits of the receiver under review, for it sets an entirely new standard of performance for suitcase portables.

Low H.T. Current Consumption.

As is implied in the title, the circuit comprises four valves. There is a single stage of tuned H.F. amplification employing a screen-grid valve, and this is followed by a detector and two stages of L.F. amplification. The output valve is a D.E.P.215, which is an excellent valve to use from the point of view of good quality of reproduction, but is generally associated also with high anode current consumption. By judicious choice of H.T. and grid bias values, however, the makers have succeeded in overcoming this difficulty without impairing quality. The total H.T. current consumption is rated at 9 mA., and in the receiver tested the measured current turned out to be 8.5 mA., the H.T. voltage then standing at 112. The H.T. battery is of generous proportions, and a life of from two to six months should be obtained, depending on the number of working hours per day. Incidentally, the question of battery maintenance is dealt with in the instruction sheet in a very frank and straightforward manner.

If the set is to be used principally for broadcast reception in the home with occasional use out-of-doors a battery eliminator should prove a sound investment, when it will be possible to conserve the H.T. battery for out-of-door use only. A special battery plug has been incorporated for this purpose.

All four valves are housed in a narrow well and are screened by means of a hinged aluminium lid. The screen-grid and output valves are mounted on hinged valve bases, which greatly facilitate the insertion and removal of valves. Cotton wool packing effectively prevents any tendency to microphonic howling.

The control panel is a model of neatness and simplicity. Tuning is effected by means of small knurled edgwise knobs, and the dial indications are read through two small windows in the centre of the panel. The right-hand control marked "Tune" operates the tuning condensers of both the frame and the H.F. circuit, while the left-hand control is a compensating device for bringing the two tuned circuits exactly into resonance.

Remarkable Receiving Range.

On the extreme left of the panel is a combined range switch and filament rheostat which serves as a volume control and may be used as an aid to selectivity. This control is matched on the right by a reaction control which works in opposite directions for long and short waves. The movement is somewhat limited and the adjustment consequently critical, but the set goes into oscillation smoothly and without backlash. In any case critical reaction is seldom necessary as the H.F. amplification is more than sufficient for normal requirements.

The sensitivity for a set of this type is truly remarkable. At a first sitting 28 stations were received after dark on the short-wave range alone, at least two-thirds of these being enjoyable at full loud speaker strength.

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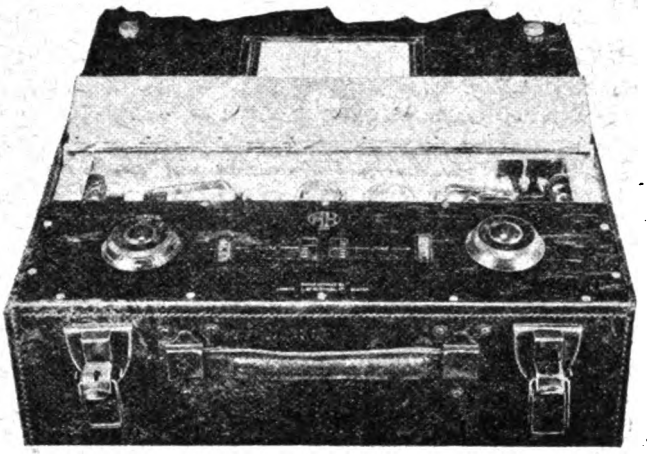
McMichael Super Range Portable Four.—
The long-wave performance is equally good, five or six stations being available in daylight as well as after dark. Local thunderstorms and atmospherics were rather troublesome during the period of the test, and it was noticed that the long-wave range was more sensitive in this respect than the short. For instance, when 5XX was seriously interrupted by atmospherics the same programme would be enjoyed from 2LO in comparative freedom.

The preliminary tests of selectivity were made 20 miles north of London, and it was found that, even with the frame set to maximum and with the volume turned fully on, interference from 2LO extended only two degrees on either side of its normal setting. Under similar conditions 5GB and 5XX spread five degrees; that is to say, distant stations could be received without interference at any setting more than five degrees from these stations. By tuning the frame to the minimum on these stations and making use of the volume control the interference from these stations could be reduced to almost negligible proportions. In this way, for instance, it was possible to receive Witzleben clear of 5GB. At a distance of one mile from 2LO conditions were naturally somewhat different. Nevertheless, one or two of the more powerful German stations were well received, and 5GB, of course, came through without a trace of interference. To sum up, we would say that the selectivity is more than adequate for most people's requirements, and the indications are that the receiver should perform satisfactorily under the regional scheme.



"Close-up" of control panel and valve compartment.

Quality of reproduction was found to be dependent to a certain extent on the tuning, and could be brought to a high standard by judicious use of the compensating tuning control and reaction. Contrary to generally accepted theory, critical reaction was used under some conditions with a marked improvement in quality. Judged in comparison with other portables the Super Range Four more than holds its own, and will undoubtedly satisfy the public demand for pleasing quality of reproduction.

Concluding Comment.

The workmanship and finish are, of course, up to the high standard which the firm of McMichael sets for itself. The leather case is of good quality and is grained to match the tuning panel and battery compartment lid.

A lucid and detailed instruction sheet is sent out with each receiver, and no question likely to arise in the mind of the purchaser is left unanswered. There is even an explanatory and reassuring paragraph dealing with the spark produced due to the charging of the reservoir condensers when the H.T. plugs are inserted. A useful tuning "abac," showing the approximate relationship between wavelength and scale reading, together with a list of the more important stations with wavelengths and frequencies, is also included.

This is one of the finest portables, irrespective of type, which it has been our privilege to test, and definitely establishes Messrs. L. McMichael, Ltd., in the front rank of original and progressive leaders of design. With provision for mains operation, and at a price (22 guineas) which competes more than favourably with ordinary domestic receivers of similar performance, the Super Range Portable Four is convincing proof that the portable is the set of the future.

CENTRING A MOVING COIL SPEAKER.

THE last operation in the assembling of a moving coil speaker, the centring of the coil in the gap in the magnet, is one which sometimes gives rise to difficulties, especially if the gap has been made as small as is considered safe in an endeavour to obtain the maximum flux across the gap for the small field-current. If the centring is done when the speaker is disconnected from the set, it is sometimes found that when the set is connected and the magnet energised the coil is no longer central, or that, although the coil appears free enough when no signals are being received, it strikes the magnet when a loud deep note, such as that of an organ, is being reproduced.

It will be found to be a very great help if the coil is adjusted while signals are being received, so that one may see that the coil is free to move over the distance required. Neither music nor speech make the ideal signal for the purpose, though either will serve if nothing better is to be had. If A.C. mains are available, it is worth while to purchase a cheap transformer, giving an output of about six volts, and to connect the secondary of this to the coil during adjustments. In this way the speaker is energised by a note of very low frequency—in the usual case, fifty cycles—so that the movement of the cone is at its maximum. With the coil swinging back and forth over the wide range that is caused by the application of six volts A.C. at 50 cycles, it is quite easy to find the setting of the centring device that allows the coil this movement without touching the magnets.

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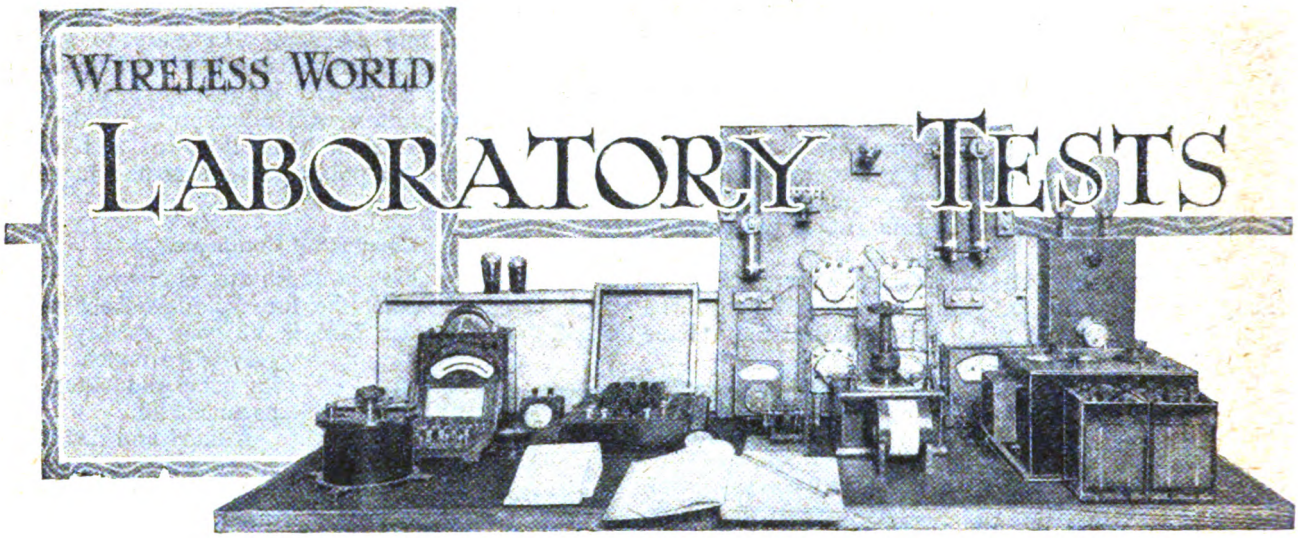

A Review of Manufacturers' Recent Products.

"CONCORD" LOUD SPEAKER EXTENSION FLEX.

This consists of two conductors, each comprising 14 strands of No. 36 S.W.G. wire, single cotton covered and vulcanised. The two wires are run parallel, and finally covered with cotton braid. A length was tested for capacity between the conductors, and measurements showed that this works out at 24 micro-mfds. per foot. Readings were made with the wire suspended in air, and do not take into consideration capacity effects to earth.

"Concord" loud speaker extension flex.

It is supplied in cartons containing 25 yards with a box of small staples, and the price is 5s. 6d. The makers are the Concordia Electric Wire Co., Ltd., New Sawley, near Birmingham.

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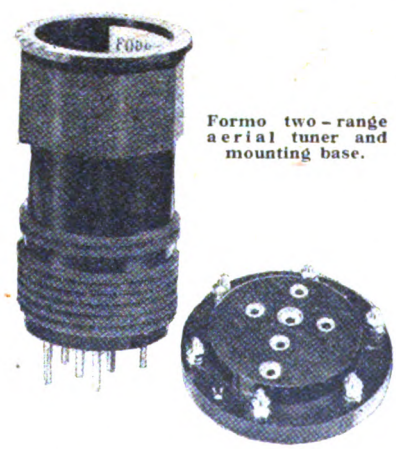
"FORMO" TWO-RANGE TUNER.

The "Formo" two-range tuner is a good example of a combined coil assembly for covering both high and medium broadcast wavebands. It consists of a cleanly moulded former 4in. high and 2¼in. in diameter, carrying a single layer winding at the top end, and a six-section pile-wound coil at the other end for loading the circuit for the long waves. These two coils are connected in series, and for medium waveband working the loading coil is short-circuited by a simple make and break switch. This is not included, but is an extra. The former is fitted with six pins, and fits into a base which screws to the baseboard of the set.

The illustration shows an aerial-grid coil suitable for use in "Reinartz" type circuits, and is provided with a reaction winding which is common to both wavebands, so that to make this practicable it has been accommodated in close juxtaposition to the long-wave coil, but well removed from the medium band portion.

The aerial is connected to a tapping on the single-layer coil, but to assure good selectivity an aerial shortening condenser of about 0.0001 mfd. should be connected between this tap and the aerial lead. Connected in this manner to a standard sized P.M.G. receiving aerial, and using



Formo two-range aerial tuner and mounting base.

a 0.0005 mfd. tuning condenser, the wavebands covered were found to be 190 to 592 metres and 840 to 1,880 metres.

The makers are the Formo Co. (Arthur Preen and Co., Ltd.), Crown Works, Cricklewood Lane, London, N.W.2, and the price of the coil only is 10s. 6d. The 6-pin coil base costs 2s.

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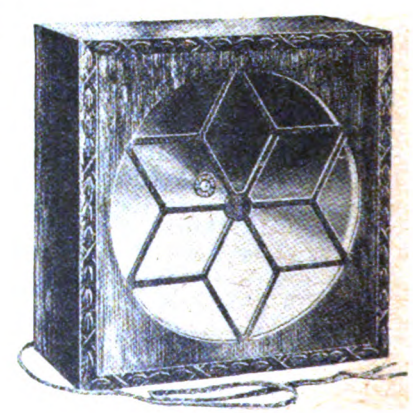
"ORPHEAN POPULAR" LOUD SPEAKER.

This is an inexpensive cabinet cone speaker selling at 30s., and made by the London Radio Manufacturing Co., Ltd., Station Road, Merton Abbey, London, S.W.19. It is available in light or dark



"Orphean Popular" cabinet cone loud speaker with an adjustable movement.

oak cabinets measuring 11in. × 11in. × 5½in. deep, and includes a 9in. diaphragm and adjustable reed movement. On the whole the quality of reproduction is good, but to obtain good sensitivity the unit must be carefully adjusted. In this state volume should be kept down to that just sufficient to comfortably fill a room of average size, otherwise the unit will show signs of distress.

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News from All Quarters: By Our Special Correspondent.

Departures from Savoy Hill.—Newspapers Without Sets.—Prague Plan Prophecies.

More Resignations.

Resignations from the B.B.C. are being maintained at a brisk rate. I hear that the next week or two will see the departure of six more engineers, all bound for the "talkies," and that another half dozen of the tribe will set off on the same pilgrimage in the very near future.

It is comforting to hear that "engineer" is an elastic term with the B.B.C. for the thought that Savoy Hill was to lose a dozen Captain Eckersleys would be intolerable.

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No "Regional" for Northern Ireland.

The only fresh item that reaches me concerning the Regional Scheme is that the projected regional station for Northern Ireland will not be proceeded with. The needs of Ulster will be covered by the existing station at Belfast, which may be slightly increased in power when the scheme approaches completion.

This arrangement should cause little or no dissatisfaction in Northern Ireland as 2BE already provides an excellent service and is, indeed, one of the most reliable of the B.B.C. group.

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Tatsfield Receiving Station.

The new receiving station of the B.B.C., now under construction at Tatsfield, is expected to be ready by the middle of August. Until then the work of wavelength checking will be continued at Keston.

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Still Experimental!

5GB suffered an unusual breakdown on Sunday, July 7th, when the start of the afternoon programme was delayed for fifty minutes owing to an air lock in a water pipe supplying the valve cooling apparatus.

As a result of this experience, special precautions are to be taken to prevent similar mishaps at the new regional stations, which shows that 5GB is triumphantly maintaining its reputation for being "experimental."

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An Appalling Mistake.

And this reminds me that a flutter occurred at Savoy Hill a few days ago when, in a Press note regarding the relaying of the Thanksgiving Service by the short-wave broadcasting station 5SW, the word "experimental" was inadvertently omitted. All sorts of dodges were resorted to in an endeavour to make amends for this appalling mistake, but it was too late.

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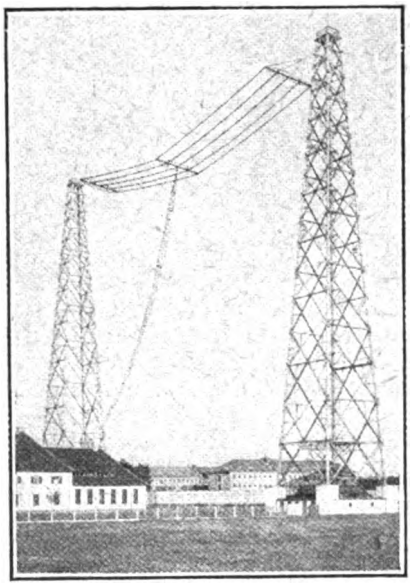
Newspapers without Wireless.

A little group of journalists attended at Savoy Hill on Wednesday last to hear Mr. H. G. Wells talk on World Peace, but I understand that they got no nearer to the great man himself than the official drawing-room, where they listened just as you and I did on a loud speaker.

Why this visit to headquarters? Surely it was superfluous? The stunning explanation is that numbers of newspapers have no receiving sets, and are thus cut off from a volcano of information which may gush forth with "news interest" at any moment.

It is true that the papers are saved the cost of the annual licence fee, but is it worth the risk?



A POPULAR GERMAN STATION. Munich, which operates on 533 metres with a power of 4kW.

Future of the Prague Plan.

Although the Prague Plan seems to be remarkably successful at the moment, prophets are arising who declare that, from a test point of view, the present season is the very worst that could have been chosen, and that the onset of winter will quickly show that the interference problem has hardly been scratched. Because signal strength is always reduced during the summer months, it is contended that stations which are now amicable neighbours will be producing unholy heterodyning by, say, October.

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M. Braillard Hands Out Bouquets.

This unhappy prediction may be correct, but for the present there is no doubt that conditions for European listening are quite good. M. Braillard, the moving spirit at the Brussels wavelength checking centre, seems immensely satisfied, and I hear that he has already distributed congratulations to various countries, notably Britain, Germany and Spain.

France is not yet settled, but it has to be remembered that the French stations are coming under a central authority for the first time, and are unequipped with official wavemeters.

Russia has yet to display a close adherence to the new wavelengths, and here, too, the absence of Brussels wavemeters may complicate matters.

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What We Really Like.

The standard of musical taste among listeners is undergoing a change, a fact which emerges from a long series of "Request" hours broadcast from 5GB. The Birmingham "Request" book now contains a preponderance of demands for so-called high-brow items, and the move in this direction is growing.

An hour of requests will be broadcast from 5GB on August 1st.

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The New Instrument.

Extract from B.B.C. official notice—

> "The cast will include . . . with a satellite of syncopation at the paino."

Possibly painful enough without the paino.

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The "Breaking-Up" of LOUD SPEAKER DIAPHRAGMS

How Nodal Points are Traced by Means of Dust Patterns.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

(*Concluded from page 35 of previous issue.*)

A CONICAL diaphragm can be compared with a bell, and we should expect to find similar markings, i.e., nodal radii or meridians and nodal circles. We are all familiar with the small household hand or electric bell, and know that its natural frequency is well within the acoustic range. Arguing by simile from our experience with the steel disc, we see that if the fundamental tone of the bell is 512 cycles it must start segmental action below this frequency. For the sake of simplicity we shall consider the vibrating object, bell, disc or diaphragm, to "break-up" at its first natural frequency.

A bell is much more rigid than a paper cone, although it is also a good deal heavier and thicker. One would expect, therefore, that a paper cone would "break-up" well within the acoustic range. If we tap a paper cone, the resulting sound cannot be described as musical in the same sense as that from a bell. The cone yields a muffled, dull sound after the nature of a thud. But, from theory and practice, we know that this thud can be resolved into a fundamental sound

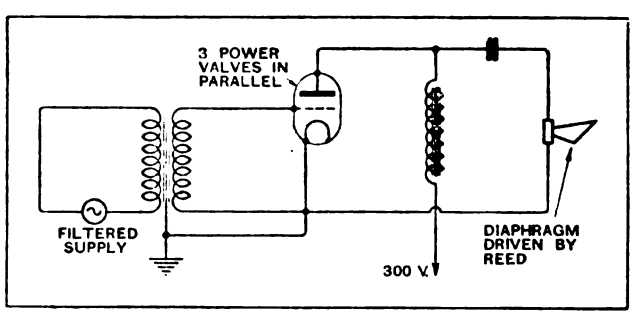

Fig. 7.—Diagram showing electrical circuit for driving cone diaphragm.

accompanied by a series of partials or overtones. Clearly the blending of these and the acoustic performance of the paper diaphragm does not conspire to produce the effect of sounding brass or tinkling cymbal. From the viewpoint of loud speaker reproduction this unusual property of the cone is distinctly helpful, although, of course, it is obnoxious at times in that it tends to colour certain reproduced sounds.

The inference to be drawn from our preceding remarks is obviously that paper cones do not move as a whole over the entire acoustic register. In fact, they "break-up" at comparatively low frequencies. From general experience I find the "break-up" frequency of a conical diaphragm of 8 inches diameter or greater to be below the middle of the pianoforte. The larger the diaphragm the lower is the break-up frequency.

Taking one's cue from Chladni, it is possible by the aid of small grains of suitable material to obtain Chladni figures which exhibit the state of motion of a loud speaker diaphragm. The apparatus used is illustrated diagrammatically in Fig. 7. Starting with a filtered supply resulting in a pure sine wave, the voltage is applied to a bank of power valves worked at anode voltage of 300 to 400, according to the amplitude desired. A suitable loud speaker movement—a reed in this particular case—with diaphragm attached, is actuated by the current from these valves. Lycopodium powder is dusted over the conical surface and the power turned on. The diaphragm vibrates and makes the powder jump. It goes on jumping until it finds lines of demarcation about which the diaphragm is vibrating in opposite directions. The behaviour of lycopodium powder has been found by early experimenters in the investigation of vibrating plates to differ from that of sand. It has been suggested that the draught created by the vibration affects the light lycopodium powder quite differently from sand.

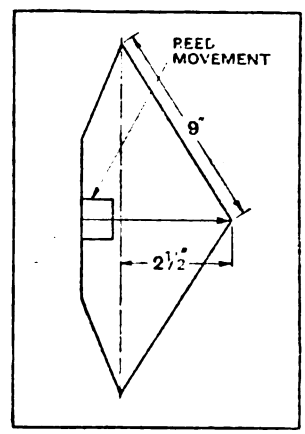

Fig. 8. — The dimensions and arrangement of diaphragm used to exhibit the "break-up" effect.

Practical Details for Successful Dust Figures.

However, in the experiments about to be described, I found that lycopodium and sand traced out the same patterns when used as a mechanical mixture or quite separately. This was fortunate, because sand slides off a conical surface so easily. So far as the diaphragm is concerned there are several points to be observed in order to obtain satisfactory results: (1) The central angle of the cone must not be too small or the lycopodium powder will merely roll to the apex. (2) The surface of the paper must not be too smooth. (3) The colour of the paper should be a good contrast with the yellow lycopodium powder. One cone of rough, brown paper, illustrated in Fig. 8, was particularly successful, because the friction on the surface was

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The "Breaking-up" of Loud Speaker Diaphragms.—

adequate to prevent sliding, but not too large for the powder to be moved by the diaphragm. The first thing is to choose a low frequency which yields no dust figure. With the above diaphragm at 80 cycles no figure appeared, so that the break-up frequency had not been reached. At 90 cycles there were signs of something about to happen, and this is illustrated in Fig. 9, which indicates a certain pattern. Now, from the case of the steel disc one would expect the conical diaphragm to break up into two segments, each vibrating about a diameter. The diaphragm did not seem inclined to act this way at all, doubtless due to rough treatment, because earlier on it unfortunately got somewhat squashed at the edge.

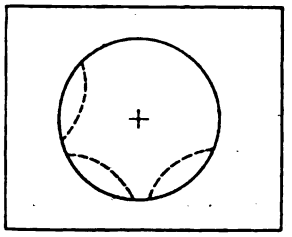

Fig. 9.—Showing the dust pattern on cone of Fig. 8 at 90 cycles.

Moreover, its mechanical and geometrical symmetry was destroyed, but this did not prevent useful information being obtained. The pattern at 90 cycles was as shown in Fig. 9, and an increase in amplitude was accompanied by "steaming" at certain points. The "steaming" is rather intriguing and occurs when the amplitude of vibration of the diaphragm is large. The lycopodium just bubbles like sea spray and is thrown off the diaphragm into this merry dance with great vigour.

Variation of Patterns with Frequency.

At a frequency just above 90 cycles six sectors appeared, as shown in Fig. 10. On pressing the surface at, say, P, the distribution altered owing to a variation in the mechanical state of the diaphragm. The powder ran up the cone towards the apex and then joined a stream sliding towards the periphery. The number of sectors increased to eight at 105 cycles, when a good deal of powder accumulated over a circle 4 inches diameter round the apex. The latter was stiffened and moved as a whole at this frequency. Beyond 105 cycles the number of sectors increased, but, owing to the accident to the diaphragm aforesaid, they were difficult to count with any degree of certainty. At 173 cycles there appeared to be 16 sectors. When a frequency of 336 cycles was reached the mode of vibration gave rise to ring markings. At 1,600 cycles there were both radial lines and rings. The lines and rings were quite irregular, due to non-homogeneity of the diaphragm. Above 3,000 cycles the movement of the diaphragm was too small to have any appreciable effect on the powder, i.e., it would not dance and play Doubtless, additional input to the valves would have achieved the desired object. It must be borne in mind, however, that where frequencies above 3,000 cycles are concerned amplitudes of a few millionths of an inch yield loud sounds. As these experiments were not conducted in a vacuum, the listener's feelings have to be considered.

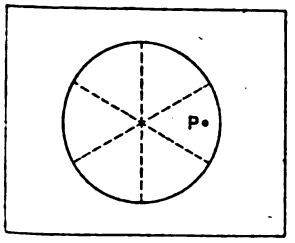

Fig. 10.—The dust pattern on cone just above 90 cycles.

Apart from the question of Chladni figures, the frequency was raised to 6,000 cycles, when it was found that removal of the diaphragm made no appreciable difference to the intensity of the sound radiated. This being so, the radiation was derived solely from the reed and its attachment mechanism to the cone—an important fact.

Summary of Observations.

To sum up the results of these experiments we can say:—

(1) Below a certain frequency a conical diaphragm will not exhibit dust figures. The absence of such figures does not mean that the diaphragm moves as a whole.

(2) At a certain frequency a conical diaphragm exhibits dust figures. With a symmetrical and homogeneous cone it is highly probable that the first dust figure is a diameter (two radial nodes), i.e., the diaphragm is divided into two equal segmental portions moving in opposite directions. In the present experiments, owing to damage to the diaphragm, this mode was not apparent to the naked eye.

(3) This first resonance or natural frequency of the diaphragm is defined as the point where it "breaks-up." The larger the diaphragm the lower the "break-up" frequency, provided the thickness and angle of the cone are the same throughout.

(4) Greater numbers of radial nodes occur at resonance frequencies above the break-up point. After a certain frequency these disappear and give rise to a nodal circle. Beyond this there are two or more nodal circles interspersed by radial nodes.

(5) This progressive break-up of the diaphragm continues until at frequencies in the neighbourhood of 6,000 cycles the sound emitted by the diaphragm *per se* is substantially zero.

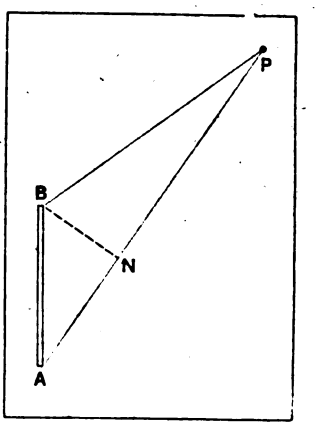

Fig. 11.—At P the sound from A is later than that from B by the time taken to travel the distance AN. AB is an edge view of the disc.

With this information at hand we have now to discuss the properties of the diaphragm as a radiator of sound. Any vibrating surface can be split up into a very large number of elemental vibrating areas (see *Wireless World*, 23rd March, 1927), and each area can be regarded as a source of sound. As we explained in the article in question, the net result of radiation from, say, a flat disc was the vector sum of the radiation from all the elemental areas. Taking the disc in Fig. 11, the point P is farther away from A than it is from B, so that the sound from B will reach P sooner than that from A.

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The "Breaking-up" of Loud Speaker Diaphragms.—

Moreover the sounds from A and B will be out of phase and may interfere if the wavelength is short enough. With a conical diaphragm at, say, 2,000 cycles, where there are a number of vibrating sectors or rings, or both, it is clear that at P the net effect at any instant is due to some areas on the cone giving positive and others negative radiation. As a case in point, take the adjacent segments X and Y of a disc (see Fig. 12). X moves forward, whilst Y moves backward, so that the net radiation at P, due to X and Y, is the vector difference of the two. But there is still another effect. If X causes a positive pressure, whilst Y causes an equal negative pressure, it is clear that there will be a circulation effect from X to Y, since the former is at the higher pressure. This will tend also to reduce the radiation pressure at P.

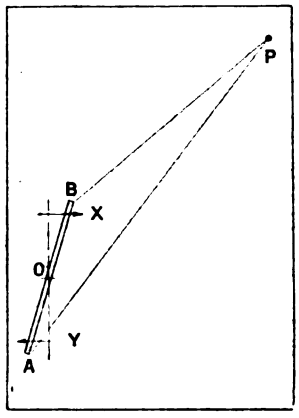

Fig. 12.—In this case the disc is vibrating about a diameter through O. The upper portion moves to the right, whilst the lower portion moves to the left. The effect at P will depend upon PB, PA and the frequency. At a low frequency the sound at P due to the two halves will cause a net reduction since one is positive whilst the other is negative.

Now, if we bear in mind the fact that as the frequency increases the diaphragm breaks-up into vibrating areas of different shapes, also that there is the circulation effect between those parts moving in opposite directions,[1] it is evident that the pressure at any point in space is the result of a very complex radiator. Instead of a simple source of sound from which the waves spread out hemispherically, we have a large diaphragm broken up into a number of vibrating areas, these representing a myriad of simple sources of different amplitudes and phases. And the pressure at any point is the vector sum of the radiation, due to all the elemental areas on the diaphragm, in combination with the circulation effect between oppositely vibrating portions.

To this hectic picture we must add the influence of transmission loss in the diaphragm. At the higher frequencies this loss is apparent, so that the amplitude of the peripheral portions of the disc will suffer attenuation. Finally, at frequencies of 5,000 or upwards the net radiation from the diaphragm is curbed by losses and interference to such an extent that its practical value is zero.[2]

With facts like these before one, it would appear to be a hopeless task to design a loud speaker to yield satisfactory results. But, taken in the proper manner, this comical performance of a conical diaphragm can be put to a very useful purpose. On the one hand we have a diaphragm whose effective area of vibration can be considered to fall away with increasing frequency. On the other we have a vibrating reed whose response increases up to, say, 3,000 or 4,000 cycles. By combining these two in the proper manner it is possible to secure a loud speaker whose response in an average room from 150 cycles upwards is quite pleasing. Of course, there are variations where the "mode" of vibration of the diaphragm alters, but these are not evinced aurally to any serious degree. By attacking the problem of the reed drive loud speaker in this manner I have been able to secure the results exemplified in the Amplion "Lion."

At the moment there exists no formula from which we can calculate the performance of a diaphragm. But by considerable practice and much experimental data the problem of loud speaker design will in time be reduced to a question of arithmetic. Just as thousands of observations and hours of computation were necessary before Kepler could formulate the planetary laws, so with the complex behaviour of loud-speaking apparatus it is equally essential that much empirical work must precede the final empirical generalisation or so-called law. Until the requisite data is forthcoming, so that the wheat can be separated from the chaff, the problem of diaphragm design must be largely based on trial and error. This must not be regarded by the pundit as unscientific. There could be no science without practical measurement coupled in its initial stages by trial and error. All theory is merely as true as the practical data from which it is formulated.

[1] "Loud Speakers," Chap. V, Iliffe & Sons Ltd.

[2] Further information on this subject will be found in "Loud Speakers," Chapters 4 and 8. In Chapter 4 the velocity of energy propagation in a diaphragm should be *less*, not greater, than that of sound.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS.

Sir,—Hearty congratulations on your editorial for July 3rd. You have hit the proverbial nail fair and squarely on the head. Perhaps a few of my own experiences might be of interest.

Last year I arranged to carry out some tests in "skip distance" with amateurs in different countries, and wished to compare the effects on 45, 32 and 22 metres. I was already licensed for 45 and 22 metres, and applied for a 32 metre permit. After about six months' correspondence with the Post Office, they told me they would give me the permit if the Radio Society of Great Britain would support my application. I wrote to the R.S.G.B. (of which I am a member) and asked them to do so. They flatly refused. I pressed for a reason, but they refused to give any.

Now, I have never done anything to deserve this, and can only suppose that this is the treatment handed out to all members. How many people are going to join a body that treats its members in this way? Personally, I would have resigned long ago, only I have always hoped that things would improve. So far they have not.

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Now, with the Washington regulations in force, I will never be able to carry out these tests, as 32 metres is now banned.

Again, some time ago, the Post Office complained to me about causing interference with B.C.L.s in this district. I knew this was impossible, as I was using very low power at the time, and in any case I never transmitted during B.B.C. hours. As the Post Office got very nasty about it, I asked the R.S.G.B. to help me, but again they turned a deaf ear. After a lot of trouble, I got the Post Office to bring down a D.F. van. They found that my statements had been correct in every way, and that no interference was caused even if I did transmit!

The R.S.G.B. nowadays seem to be more concerned with "Conventionettes" and social gatherings than with honest experimental work.

I sincerely hope that your efforts for reform, and the raising of amateur status, will meet with the reward they so richly deserve.

A. JAMISON.

Bangor, Co. Down.

Sir,—In congratulating you on the manner in which you are utilising your leading articles of late to draw attention to the deplorable state of the transmitting amateur in this country I beg to draw your attention to an important factor to which you have not referred. Whilst agreeing that the R.S.G.B. is the recognised organisation for the transmitting amateur (for in its enthusiasm to retain this position it has practically ceased to be of any use to the non-transmitter), it has certainly declined in activity as regards fighting the P.M.G. for the amateur's rights. This may be due to certain aversion to quarrelling with its own officers.

The Association of British Radio Societies, an organisation which exists for, and serves, every class of amateur, has in its short existence been of an appreciable help to the transmitter in connection with the steps taken by the P.M.G. to enforce the regulations of the Washington Conference. It was directly connected with the granting of a further month's breathing space after the P.M.G.'s ultimatum of October last, and also with the approving by the Post Office authorities of a commercially made absorption type of wavemeter for use with transmitters. This Association is, I believe, the very organisation that will prove capable of so combining the interests of the Radio amateur that a united front will automatically be formed to withstand the assaults of officialdom, the only sure way of obtaining results. It is up to the amateurs themselves, therefore, to support this comparatively new body and enable it to carry on with a greater power the good work that it has already started.

At the recent Convention held at the North-East Coast Exhibition at Newcastle, where both the A.B.R.S. and the R.S.G.B. were represented on the platform, the delegates of the former body were able to inform the audience that in no single case had a society, or individual, lost its transmitting licence (in the recent reshuffling) when the matter had been looked into by the Association.

R. M. KAY, B.Sc.

Manchester.

Sir,—On behalf of the Association of British Radio Societies we wish to express our appreciation of your leading articles of June 19th and July 3rd.

The A.B.R.S. for its part has for some time been fostering a spirit of mutual respect and esteem between its members and the officials of the Post Office. We think that our efforts with regard to the question of frequency controlling apparatus for use at amateur transmitting stations may be taken as a case in point. We don't wish to claim all the credit for getting the Post Office to modify their conditions, but as has already been fully reported in our Association journal—"British Radio"—we kept up a lengthy correspondence with the Post Office until they accepted most of our suggestions.

We quite agree that the amateur (particularly with regard to transmitters) has suffered much discouragement at the hands of the Post Office, but we venture to suggest that the amateurs (or at any rate a section of them) have not, as you put it, "permitted themselves to be crushed without showing the resentment of the proverbial worm." This Association has done its best to procure official understanding of the amateur's difficulties and will continue to do so, believing that the Post Office authorities are open to reason with representative opinion.

We are also substantially in agreement with your remarks about the present conduct of the Radio Society of Great Britain and its policy (or the lack of it).

The A.B.R.S. would probably never have come into existence had the R.S.G.B. fulfilled its claims and obligations. For that slackness on the part of its former officials the committee must accept the ultimate blame, but nothing is more certain than that if the R.S.G.B. had lived up to its national title (instead of being conducted as a "glorified London wireless society") the amateurs would have been in a much stronger position than at present obtains. We have no desire to rake up a good deal of what has passed, but we do wish to associate ourselves very cordially with your stand on behalf of the amateur, and to say that we shall always be glad to co-operate with you in any activity which will assist the improvement of the amateur status in this country.

LEONARD A. GILL,
Hon. Secretary, Association British Radio Societies.
J. HARTLEY,
Hon. Managing Editor, British Radio.

Sir,—As an old reader of this fine journal I wish to heartily congratulate you on your splendid editorial articles on behalf of our amateur transmitters.

It is high time a "strafe" should be started against these insane regulations, which, forced upon us by an administration whose crass ignorance, greed and suspicion of amateur radio matters, places the amateur under an official stranglehold, and also fails to "protect" the P.O. in actual practice.

On the other hand, I cannot agree that the amateur is "petering out," for at the time of writing amateur transmission in this country has never before reached a higher degree of enthusiasm, activity, or actual numbers of stations. Granted a few stations owned by electrical concerns, etc., have returned their permits under the new regulations, but they have been replaced many times over by new and enthusiastic amateur transmitters since the regulations came into force, and our ranks are swelling splendidly month by month. What we require is a live-wire society to represent us, one that will not take "no" for an answer, and is prepared to raise its voice and fight to an end.

Things badly required are:—

Full width of *all* Washington amateur wavebands; abolition of the absurd 10-watt restriction; full permission to handle public or service traffic in cases of emergency, together with an organised network of stations to deal with same.

Another point often overlooked is the great value of amateur radio as an international peace agent. I am convinced that if every other member of the community was a "ham," international dispute would be a thing of the past, for one has only to listen to the cheery chats and jokes between the world's amateurs to realise this.

May your efforts be crowned with success, and more power to your very fine journal.

"FED-UP G HAM."

Surrey.

'JUNK"—A SUGGESTION.

Sir,—Wireless amateurs often have problems to solve, but none perhaps so awkward as the question of what to do with old apparatus. One writer in "Current Topics" recently appealed for discarded apparatus to start a working lads' wireless club. But who wants burnt out transformers and obsolete forms of inductances and the copper wire that has done its duty once or perhaps several times in sundry sets and is now too kinked to be of any further use? My suggestion is that the wireless societies up and down the country should collect scrap copper on behalf of the hospitals. This should form a very useful source of "pin money" to them with copper at 1s. 4d. per lb. and likely to become dearer rather than cheaper on account of the increasing demand for this metal. The revenue from this source might quite soon become equal to that from the tinfoil collecting which is now so ubiquitous and popular, especially as pounds of scrap copper are to be found lying about, compared with mere ounces of tinfoil.

I offer this idea for your consideration, and although I am not in a position to organise a collection on national lines, I could start the ball rolling with a few pounds of scrap aerial wire, etc.

H. W. KENDALL.

(Wireless and Experimental Association).

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READERS' PROBLEMS

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Testing an L.F. Transformer.

Thinking that the windings of my L.F. transformer had become defective, I have recently been carrying out a test. When telephones and a dry cell were connected in turn across primary and secondary terminals, clicks were produced, and were of greatest intensity when the circuit through the primary was completed. This, I take it, suggests that everything is in order.

Now for my trouble. The transformer was replaced and connected up in the set, and telephones were again connected across its terminals. Signals were observed to be very much louder with a connection across the primary than across the secondary; surely this should be reversed, on account of the voltage step-up that should take place? G. P. N.

The effects you describe would indicate that the transformer is in good condition, and it is quite natural that signals should be louder when telephones are connected across the primary terminals than when they are transferred to the secondary. This is because the latter winding has in all probability an impedance that does not match that of the telephone windings, and consequently the power delivered is greatly reduced.

o o o o

Simplified Pick-up Connections.

In your recent description of the McMichael Home Constructors' set, it was mentioned that provision was made for connecting a pick-up in an extremely simple manner—by joining one terminal directly to the detector grid and another to a negative bias voltage point. My own receiver is, in broad outline, somewhat similar to the one under discussion, but a transformer-coupled H.F. stage is used; would this method of connection still be applicable, and, if so, will you please give me a circuit diagram?

By the way, I cannot quite see how the application of a positive potential to the grid is avoided without disconnecting the grid leak. D. C. G.

In that you are using transformer coupling the position is not affected at all; in fact, this method of connection is applicable to any set having a grid detector. We show in Fig. 1 the method of making the addition to your own set. Of course, if it is more convenient, there is no objection to taking bias for the detector valve (when it is converted to a first stage L.F. amplifier) from the H.F. valve bias cell.

It is quite unnecessary to disconnect the grid leak, as the positive potential

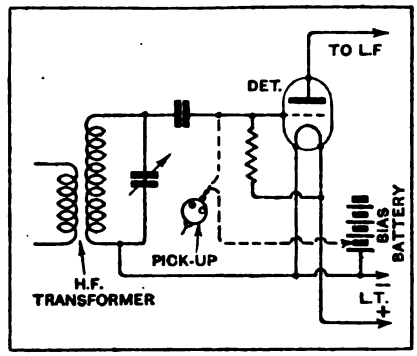

Fig. 1.—Method of connecting a pick-up in a grid detector circuit.

impressed through it on to the grid will be completely annulled by the voltage applied directly from the battery.

o o o o

Voltmeter Resistance Rating.

I read that voltmeters are generally rated in "ohms per volt." Can it be taken that my moving iron meter marked "4,000 ohms" has a total resistance of 600,000 ohms (4,000 multiplied by 150), which is the maximum voltage reading? S. D. J.

No, in this particular case the marking on the meter will indicate its total resistance.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

A.C. Valves and Quality.

Is there any reason why a set with indirectly heated valves should not give the best attainable quality of reproduction? I ask this question because the great majority of sets designed purely from the quality point of view seem to include battery-heated valves. E. T. C.

Battery operation is adopted as a safeguard against A.C. potentials reaching the early stages, and particularly the detector. At present the range of A.C. valves is limited, while for the small current taken one can make a choice from an extensive range.

o o o o

L.F. Amplifier Considerations.

I am sending you a circuit diagram of my proposed receiver. Will you please criticise it, bearing in mind that I require a large undistorted output, and sufficient sensitivity to enable me to receive my two nearest stations (respectively about 40 and 60 miles distant) with an ample margin of safety? Long-distance reception is of secondary importance, although, as I am favourably situated, I expect to be able to receive a number of foreign transmissions when conditions are reasonably suitable. A. P. P.

The circuit diagram submitted by our correspondent shows a single H.F. stage with an A.C./S. valve, transformer-coupled by an anode bend detector, and up to this point is fairly conventional. The detector—an A.C./G.—is transformer-coupled to a pair of P.625a valves in a push-pull arrangement; this, in our opinion, is open to criticism." Assuming normal operating conditions, an incoming signal sufficiently great fully to load the detector valve will give rise to L.F. impulses on the grids of the output valves of an amplitude appreciably below that which they are capable of handling, and thus the arrangement is not altogether economical. In other words, it will be impossible to avail one's self fully of the somewhat ambitious capabilities of the output valves without producing distortion at the detector stage.

An easy way out of the difficulty is to use as a detector an A.C./R. valve, which is capable of accepting a considerably larger input voltage, but which has the disadvantage that it will reduce the overall sensitivity of the receiver. Of course, there is the alternative of interposing another L.F. stage.

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AMATEUR STATUS.

IT is really a very simple matter to offer a criticism on the way in which the affairs of the organisations of the amateurs in this country are being conducted, but what is needed is not destructive criticism but co-operation in the right spirit with the object of ensuring that the mistakes of the past will not be repeated, and that amateurs throughout the country, no matter to what group or society they may belong, are encouraged to support a common policy which will ensure the maintenance of reasonable facilities for experimental work. There may be a number of societies and organisations independently constituted, and it would seem to us that there is no need for such organisations to be broken up in order to establish an extra body representative of the political views of amateurs generally, nor should it be necessary for any new organisation to be formed for this purpose if the Radio Society of Great Britain is prepared to undertake the work in the proper spirit.

We think that sufficient demonstration has already been given through our Correspondence columns, and through comments which have been made amongst amateur gatherings, since we raised this subject to convince the officials of the Radio Society of Great Britain that they no longer enjoy to a sufficiently full extent the confidence of the British amateur. Proposals should now be forthcoming from the Radio Society, having as their object the reinstatement of their Society as an organisation representing the amateur of this country, whether transmitter or general experimenter. Suggestions have been made by certain contributors to our Correspondence columns that the Radio Society of Great Britain is of no use. We are by no means prepared to endorse this view, since we consider that every amateur organisation in this country is of importance, and amateur status certainly cannot be maintained or strengthened by weakening or breaking those organisations which already exist to bring amateurs together on common ground. The Societies unquestionably form the only nucleus through which the desired result can be achieved, but the officials of the Societies must co-operate in the right spirit and sink petty differences which may exist because they know that the main issue, that of securing freedom for the amateur, is a policy with which they are all in agreement.

* * * *

TELEVISION.

THOSE who may have been optimistic enough to look for early co-operation between the Baird Company and the B.B.C. to bring about actual television broadcasts will have been disappointed with the recent news that negotiations for arranging television broadcasts which have been in progress between the B.B.C. and the Baird Company have been broken off.

It is understood that one of the principal reasons for the breakdown in negotiations is that the Baird Company insisted upon a bigger apportionment of programme time than the B.B.C. was prepared to concede initially, and, further, the Baird Company required a guarantee that that time would be devoted to television broadcasts by the B.B.C. over a long period.

We appreciate the difficulties which the Baird Company must be experiencing, for unless it can guarantee a reasonable period during which transmissions will take place, it becomes very difficult for the company to offer receiving apparatus for sale to the public. On the other hand, the necessity for the B.B.C. to exercise extreme caution before conceding to the allocation of considerable programme time daily for two or three years must be apparent to everyone.

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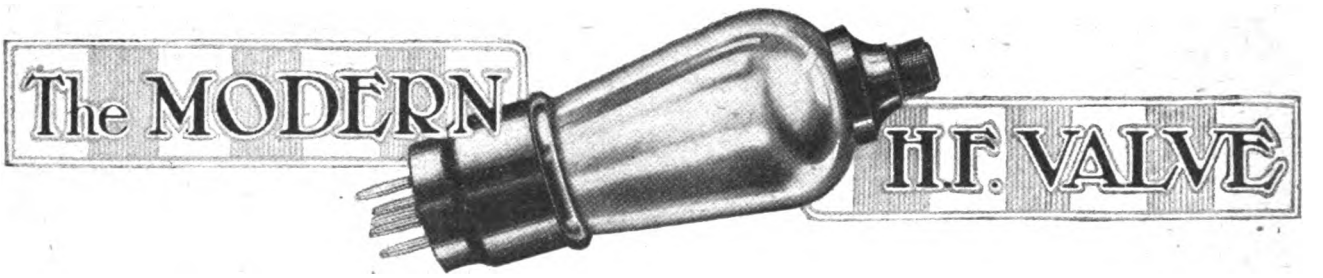


Single Stage Amplification of Two or Three Hundred with the New Screen-grid Valve.

By W. I. G. PAGE, B.Sc.

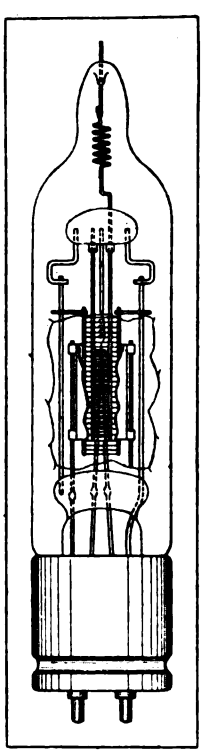
Shall I neutralise my screen-grid valve? What maximum amplification shall I get before oscillation occurs if I do not neutralise? If a three-to-one H.F. transformer with an S.G. valve is used instead of the optimum value of about one-to-one in order to obtain really good selectivity, what stage gain shall I lose? These and many other similar questions which the amateur often asks himself are answered at some length in the accompanying article. A table is given showing the remarkable characteristics of the new H.F. valves which without doubt will considerably improve the performance of radio receivers during the coming season.

SUCH strides have lately been made in the science of H.F. amplification that we now glibly talk of single stage amplifications of 200 or 300. By this we mean that a signal of 1 volt applied to the grid of the H.F. valve will be amplified by the valve and its coupling, and be impressed on the grid of the next valve (the detector when there is only one H.F. stage) as 200 or 300 volts. Dealing with practical figures such as we should meet in receiving a fairly weak transmission, it would be more reasonable to say that 1 millivolt would become 200 or 300 millivolts. A short time ago stage amplifications of 40 or 50 were considered superlative.

H.F. Valves Compared.

There is now on the market a series of screen-grid valves with indirectly heated cathodes having remarkable characteristics; furthermore, a number of the familiar battery-heated screen-grid valves have been redesigned and a new range of three-electrode H.F. valves for A.C. mains is available. With such an abundance of types, and so many characteristics within each type, the choice of the best valve and coupling for any specified conditions becomes a matter of increasing difficulty, and it is the purpose of these notes to examine the relative merits of some twenty typical H.F. valves with a view to finding the maximum stage amplification which can conveniently be obtained with them.

It will be shown that in the case of screened valves the residual anode-grid capacity, small as it is, plays a very important part in the H.F. amplification which can be attained before self-oscillation sets in. In the original screened valve designed by Hull at Schenectady over three years ago, the interelectrode capacity was reduced to 0.006 micromicrofarads—a remarkable achievement—but the valve was of an experimental nature and could not be produced commercially in quantity. A perfect metal shield around the plate of a valve to prevent that electrode and the grid from becoming a small condenser would mean that no electrons would pass to the H.T. battery, and thus there would be no plate current.



The Hull valve, the forerunner of the screened grid.

The perforations in the shield to allow the passage of a satisfactory electron stream must perforce mean a compromise between negligible electrode capacity and useful valve characteristic. The earliest British commercial screened valve—the S.625—had an anode-grid capacity of about 0.1 $\mu\mu$F, and whereas this value was a great improvement on that of the best three-electrode valve, it was not possible at, say, 300 metres to get a stage amplification of more than about 39, however perfect the external screening of circuits might be made.[1] The tiny reaction condenser within the valve feeding back energy from the output to the input was of sufficient capacity to cause oscillation to start when coils of quite unambitious design were used.

Amplification and Valve Capacity.

Many readers probably found that the limit of amplification was reached with ordinary plug-in coils, and that the use of a Litz solenoid coil simply meant uncontrollable oscillation. Actually, coils having a dynamic resistance of about 80,000 ohms at resonance[1] (at 300 metres) were the highest values permissible. A neutralised triode in those days would give an amplification of the order just mentioned—admittedly with rather specialised

[1] See *Experimental Wireless*, October, 1927, p. 625.

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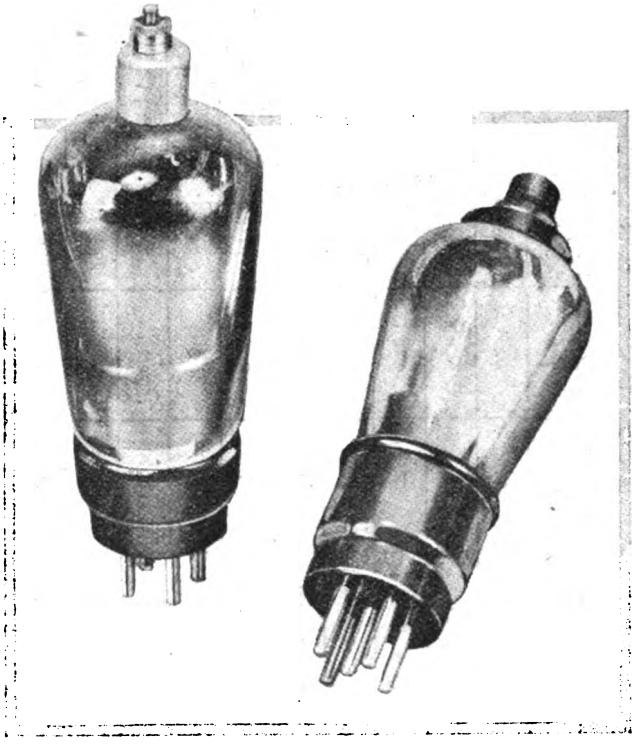
The Modern H.F. Valve.—

and expensive coils—but even then the screened valve had little to recommend it.

The position to-day has vastly changed. Not only has the S.625 an anode-grid capacity five times less than that in the early examples, but there are at least two screened valves now available which have inter-electrode capacities as small as that in Hull's experimental valve (0.006 $\mu\mu$F). Let us translate this into terms of maximum possible amplification before oscillation sets in. Knowing the valve constants, and taking the lowest frequency in the medium broadcast band —namely, 200 metres—where instability will be greater than at 600 metres, due to the lower reactance of the tiny condenser at the higher frequency, it is within the realms of fairly simple mathematics to find an expression which will give the maximum stage amplification just before the threshold of instability is reached.

Further, we shall be able to show how low the losses in the grid and anode coils may be made (*i.e.* how high the dynamic resistance can be) before the capacity reaction resulting from the internal anode grid condenser will cause oscillation to commence. Such investigation of critical values assumes, of course, that external stray capacity, magnetic and common resistance couplings between output and input circuits, have been properly eliminated by efficient decoupling and meticulous attention to complete screening in metal boxes.[2]



On the left is the Mazda S.G.215 screened valve having the extremely low interelectrode capacity of 0.005 $\mu\mu$F. The new Cossor screened valve for A.C. mains is illustrated on the right.

In the appendix to this article will be found the necessary formulæ which have been extracted from a treatise on this subject in *Experimental Wireless*[3] written by Dr. R. T. Beatty. The stage amplification figures found for a number of screen-grid valves on the market are given in column 12 in the accompanying table, wherein, instead of 39, we find such remarkable figures as 206, 152, 88, etc. It must not be forgotten that up to now we have not considered neutralising; the valve capacities of column 11 have been allowed to exert their influence without hindrance. The vast improvement in stable H.F. amplification is due not only to enhanced mutual conductance in conjunction with high amplification factors, but also in no small measure to a study by valve makers of the methods of reducing interelectrode capacity.

In column 13 of the table the maximum permissible dynamic resistance of equal tuned grid and tuned plate circuits is given. That is to say, assuming, for the sake of simplified mathematics, that similar coupled tuned grid and tuned plate coils are used, the figures given in the column concerned show the lowest loss coil it is safe to employ before the threshold of instability is reached at 200 metres. When this coil is used the maximum amplification is the figure given in column 12.

When it is an Advantage to Neutralise.

As an example, a coil (280,000 ohms) of even lower losses than that generally used in an *Everyman Four* type of receiver (computed at about 250,000 ohms dynamic resistance (would have to be used with an unneutralised Mazda S.G.215 valve before oscillation started and, if perfect external screening were arranged, there would be a stage amplification of about 152. The tuned plate circuit specified is the same as a one-to-one transformer, which must be used with practically all screened valves for *maximum* amplification (see column 7).

Before we turn to the question of the advantages of neutralising, for the sake of interest and to show the extraordinary advance made in the last few years we will cite an example of the best unneutralised amplification that we could extract from a triode. Reference will be made to an old and trusted friend — the D.E.5B. valve. By working out from expression (*c*) in the appendix, the threshold instability amplification at 200 metres, assuming the anode-grid capacity as 10 $\mu\mu$F., we find the figure of 3.4. That there are now available in this country valves with an interelectrode capacity 2,000 times less is a great tribute to the research laboratories of the British valve manufacturers.

It will now have become clear that the limiting factor of amplification with screen-grid valves is chiefly the valve capacity and perfect screening. If we can nullify the effect of this capacity by neutralisation the limit to amplification is the highest dynamic resistance to which the tuning circuits can be designed. The numerical treatment of stage gain when using neutralised H.F. transformers has already been dealt with so lucidly in the pages of this journal[4] by A. L. M.

[1] See "Metal Cabinets," *The Wireless World*, July 10th, 1929.
[2] October, 1927, and January, 1928.
[4] *The Wireless World*, April 24th, and May 1st, 1929.

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H.F. VALVE STATISTICS

(*Wireless World* 24th July 1929)

1	2	3	4	5	6	7	8	9	10	11	12	13
VALVE	MAKER	TYPE	AMPLIFICATION FACTOR	A.C. RESISTANCE	H.F. PERFORMANCE FACTOR	OPTIMUM TRANSFORMER RATIO	NO. OF PRIMARY TURNS	MAXIMUM STAGE AMPLIFICATION NEUTRALISED	STAGE AMPLIFICATION WITH 3:1 RATIO TRANSFORMER	VALVE CAPACITY (ANODE-GRID) ($\mu\mu f$)	MAXIMUM STAGE AMPLIFICATION UNNEUTRALISED	LOWEST LOSS COIL FOR COL. 12 DYNAMIC RESISTANCE (ohms)
AC/S.	COSMOS	S.G/A.C.	1200	800,000	132	1	68	290	121	0·006	208	165,000
AC/G.	··	T/A.C.	35	17,500	26	3·8	18	66	—	—	—	—
SP/610G.	··	T.	19	11,000	18	4·8	14	48	—	—	—	—
220 S G.	COSSOR	S.G.	200	200,000	45	1·12	61	112	73	0·023	75	—
41.M.SG.	··	S.G/A.C.	400	200,000	89	1·12	61	224	146	—	—	—
41.M.HF.	··	T/A.C.	25	14,000	21	4·2	16	52	—	—	—	—
610 H.F.	··	T.	20	20,000	14	3·54	19	35	—	—	—	—
H.F. 610	EDISWAN	T.	25	21,000	17	3·45	20	43	—	—	—	—
S. 215	MARCONI AND OSRAM	S.G.	170	200,000	38	1·12	61	95	62	0·014	81	184,000
S.625	··	S.G.	110	170,000	27	1·2	57	66	46	0·022	55	—
DEH.610	··	T.	40	60,000	16	2	34	40	—	—	—	—
HL.610	··	T.	30	30,000	17	2·9	24	43	—	—	—	—
DE5.B.	··	T.	20	30,000	12	2·9	24	29	—	(10)	3·4	—
S.G.215	MAZDA	S.G.	300	270,000	58	1	68	144	84	0·005	153	280,000
PM.16	MULLARD	S.G.	200	200,000	45	1·12	61	112	73	0·015*	88	160,000
PM.S4.V.	··	S.G/A.C.	1000	1,330,000	87	1	68	158	61	0·015*	98	—
PM.354.V.	··	T/A.C.	35	14,000	30	4·2	16	73	—	—	—	—
PM1.H.F.	··	T.	18	22,500	12	3·3	21	30	—	—	——	—
PM5.X.	··	T.	17·5	14,700	14	4·1	17	36	—	—	——	—
PM.26	··	P.	50	25,000	32	3·2	21	80	—	—	—	—
SS.215.SG.	SIX-SIXTY	S.G.	190	220,000	41	1·07	64	102	64	—	—	—

Columns 6, 7, 8 and 9 refer to H.F. transformer coupling for triodes and screened valves, whilst in columns 10, 11, 12 and 13 are given certain data for screened valves only. Columns 12 and 13 refer to the case where a one-to-one transformer (or tuned anode) is used and where it is assumed that the tuned grid and tuned plate coils have the same dynamic resistance

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The Modern H.F. Valve.—

Sowerby that little more need be said here. Taking an *Everyman Four* type of H.F. transformer and using a neutralising winding of an equal number of turns to the primary for triodes, and one or two neutralising turns for screened valves, the optimum transformer ratio is given in column 7. Assuming a 68-turn secondary of Litz wire, the number of primary turns is shown in column 8, and the maximum possible stage amplification when using such a transformer in column 9.

It is somewhat intriguing to compare the figures of columns 9 and 12 for screened valves. Where the valve capacity is, say, over two hundredth of a micromicrofarad there would seem to be considerable advantage in neutralising if we grant that the slight added complication is compensated for by the extra percentage amplification. Alternatively, the table shows that when using coils of the *Everyman Four* type there is little to be gained as regards amplification by neutralising those screened valves which have internal capacities under one-hundredth of a micromicrofarad. If coils were to be designed with a dynamic resistance of something over 400,000 ohms, a valve like the AC/S, when neutralised, would undoubtedly give the unprecedented stage amplification of 400 or 500. Under these conditions the neutralising of a screened valve has a very real advantage.

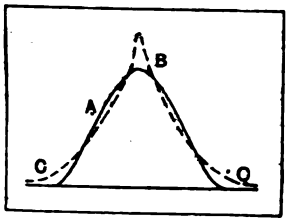


Fig. 1.—Having chosen a stage amplification for a screened valve which is a little below the point at which instability occurs when the valve is unneutralised, the resonance curve for the same stage amplification when the valve is neutralised is shown as A above. The resonance curve for the case when the valve is unneutralised shows a peak at B with likelihood of sideband cutting and the broad skirts at C suggest poorer selectivity.

With a valve like the Mazda S.G.215 we are in a position to attain an amplification of about 150, either neutralised or unneutralised, and it might be interesting to compare the type of resonance curve in each case.

In Fig. 1, A represents the neutralised case; the (dotted line) unneutralised curve, due to the assistance of valve capacity reaction, will have a peak as at B suggesting sideband cutting, while the somewhat broad skirts shown at C may cause the selectivity to be a little worse than that of curve A. It is probably unlikely that the effects of B and C would be aurally perceptible unless the threshold figure in column 13 were practically reached.

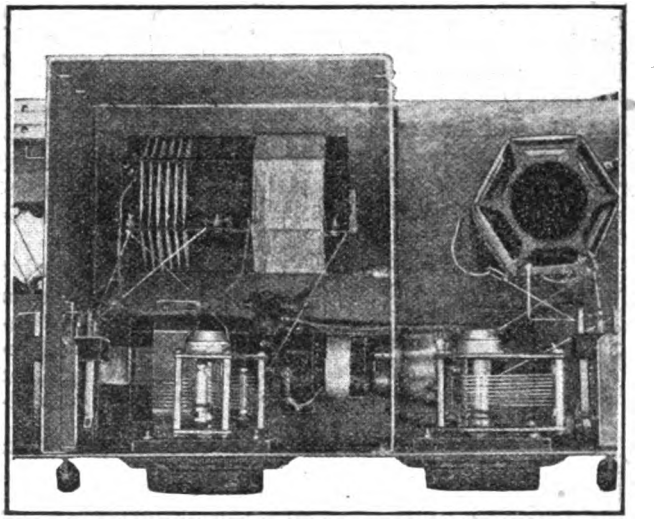
Selectivity and the Screened Valve.

We must now turn our attention to selectivity with screened valves. It has been shown by Dr. McLachlan[1] that in a high-frequency transformer the effective capacity across the primary is equal to the capacity across the secondary multiplied by the turns ratio squared. As screened valves demand a transformer of approximately one-to-one ratio for maximum stage amplification the selectivity will always be poor as compared with that of an *Everyman Four* type of receiver where, with a neutralised triode, the optimum turns ratio is, say, three- or four-to-one. The obvious corollary is to forgo a part of the amplification of the screened valve and use a transformer with a step-up ratio and regain our lost selectivity.

The important question now arises as to whether in obtaining this selectivity we have not reduced the amplification of the screened valve to the level of the cheaper triode. On the assumption that a three-to-one transformer adequately meets our needs, is the amplification reduced to one-third, a figure which in general would make the screened valve hardly worth while? Luckily, the answer is in the negative.

Modified Transformer Ratios.

In the appendix the expression (*d*) gives the stage amplification where any non-optimum turns ratio is employed with a screened valve when the primary dynamic resistance is *not* equal to that of the valve. In column 10 the stage gain with a three-to-one transformer is worked out, and can conveniently be compared with the figures for a one-to-one transformer in column 9. Presumably where the figures of column 10 are well below the threshold instability figures of column 12 neutralisation is unnecessary, but it must not be forgotten that column 12 refers to tuned plate circuits (or one-to-one transformers). It would be as well to point out that when really powerful interference from a local station is experienced, not only is a selective interstage coupling necessary, but a coupled aerial circuit is almost essential. These remarks will have more force when the transmissions from Brookman's Park commence.



Completely screened H.F. stage with two-range switching and S.G. valve. An H.F. amplification of 50 can be readily obtained. (From the "S.G. Regional Receiver.")

If instability persists when the stage is unneutralised, and when a step-up transformer is being tried in order to gain the necessary selectivity, further turns should be removed from the primary rather than that any attempt should be made to damp the low-loss secondary.

(*To be concluded.*)

[1] *Experimental Wireless*, October, 1927, p. 600.

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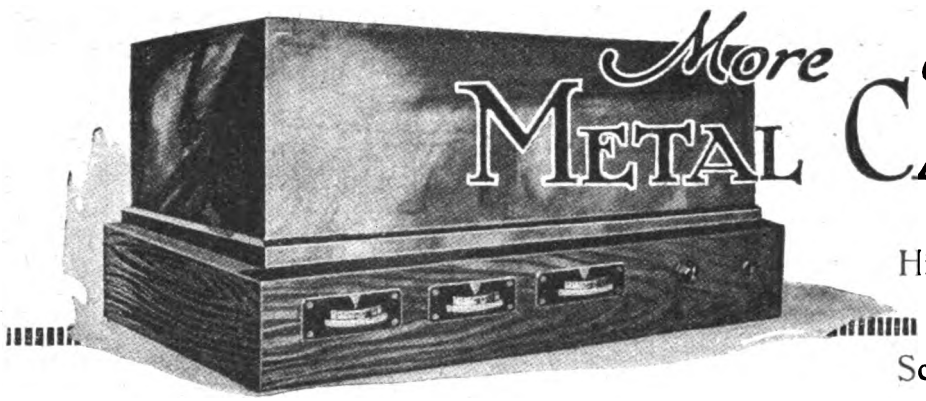


More about Metal Cabinets

Hints on the Design of Screening Containers.

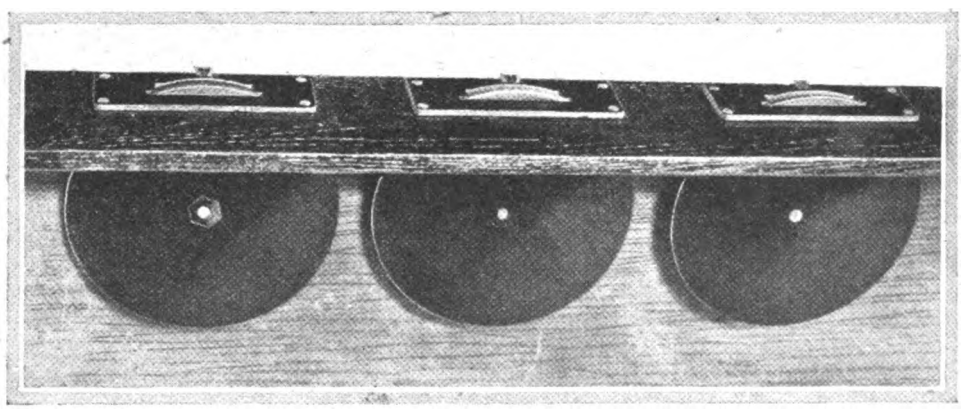
SETS with a single screen-grid high-frequency amplifying valve tend to become much of a muchness, or, at any rate, no particular design seems to manifest that clearly perceptible superiority in sensitivity and selectivity shown by, say, an "Everyman Four" type of receiver when compared with a more conventional arrangement of neutralised three-electrode valve. The set designer has more scope than ever for his abilities when dealing with the detector-L.F. part of a receiver, but with regard to the H.F. amplifier something approaching an *impasse* has been reached. In the case of ordinary S.G. valve circuits, it is comparatively easy to attain a certain level of amplification, which is limited to a value below the theoretical maximum mainly by two factors—residual capacity in the valve and interaction between circuits. The first is entirely a matter for valve manufacturers, and already a great deal has been done; the second is amenable to treatment, but it is a waste of time to observe any extraordinary precautions, say, in decoupling, when advantages so gained will be offset by direct magnetic or capacitative inter-circuit couplings due to the imperfect screening that is generally used.

When inter-circuit coupling through residual valve capacity reaches a high value, there is little point in taking special pains to avoid other linkages, but nowadays this capacity has, in nearly every case, been reduced to a very low figure, and valves with even greater merit in this respect are expected to be shortly available. In order to derive the fullest possible benefit from them, it will be essential to avoid interaction in every possible way, and there is certainly room for improvement in our present methods of screening.

An All-purpose Screening Case.

In an article in *The Wireless World* for July 10th attention was drawn to this matter, and suggestions were made as to the design of a metal screening case with a wooden base, suitable for housing modern receivers with one or two high-efficiency H.F. stages. That the subject is considered to be important is shown by the fact that this article has evoked a good deal of correspondence both from amateurs and from the wireless trade; both seem to be in complete agreement with the views expressed, and, as no really unfavourable criticisms of the design or demands for sweeping modifications to it have been received, it may safely be assumed that something on the lines suggested will meet the case, and, in consequence, some further hints are offered.

Although thorough screening is of such importance, it is well to dispel a prevalent illusion as to the benefit conferred by it. It is sometimes thought that the performance of *any* "H.F." set will be improved by completely isolating its circuits in separate compartments instead of using less-complete screening. If the receiver is so designed as a whole that its H.F. amplifier is normally stable, no improvement whatever is likely to be brought about by this alteration; indeed, it may be slightly less sensitive than before, due to a decrease in incidental reaction effects. Generally speaking, it pays to make the alteration in question only when the H.F. valve tends to oscillate under optimum operating conditions, or when a complete re-design of the H.F. portion, involving the use of more lightly damped circuits, is proposed.



View from below showing position of condenser drums inside the base. These are experimental dials turned from ¼in. sheet ebonite, with an over-all diameter of 5¼in.

As stated in the earlier article already referred to, tuning condensers must be

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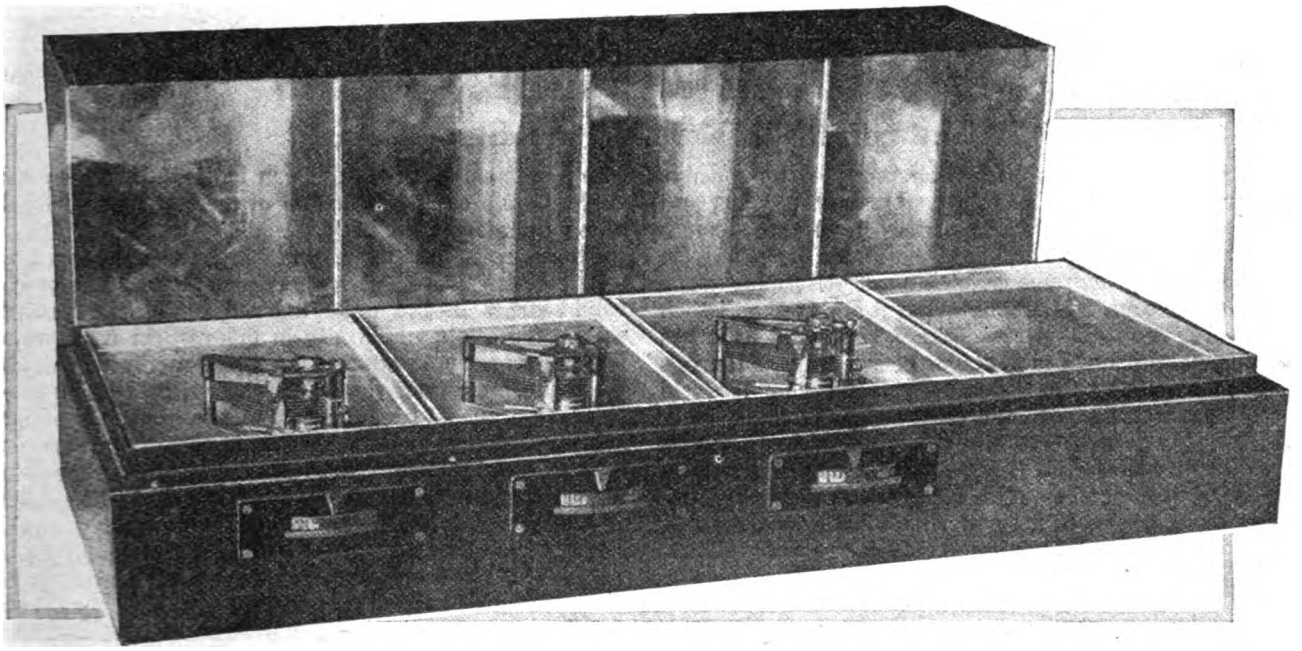
mounted with their spindles in a vertical plan, and consequently edgewise dials of fairly large diameter must be used. We may assume that the centre of the " one-hole fixing " bush will be located 1½in. behind the front edge of the screen (at least 90 per cent. of components on the market may be so mounted); allowing for the wooden base to project an inch beyond the front face of the screen, the control drums must be between 5½in. and 5¾in. in diameter. This seems large, but it must not be forgotten that very fine adjustments can be made on the knurled periphery of these drums, and that reduction gearing will no longer be necessary. In any case the designs of both cabinet and condenser drums are interdependent, and, if a smaller edgewise dial is preferred, it will be necessary that the projection of the wooden base be reduced.

There are almost innumerable ways of arranging for good electrical sealing at the junctions between the edges of the removable metal cover and its partitions and the metal base. Instead of using deep channels with spring edges—with or without braided metal tape gaskets or something similar—it is possible to make comparatively shallow depressions in the sheet of metal, and to fit strips of braided tape to the edges of the cover, which would be provided with brackets and screws or spring clips to hold it firmly into position, with metal surfaces forced into close contact. It will be obvious that the cover should be readily removable when interchangeable coils are used in the receiver, although this feature is of minor importance in " switch-over " sets. An electrical seal may be quite effective, even though there may be small imperfections or apertures at a number of points along the joint, but a lengthy seam with its surfaces apart or in imperfect contact must be avoided like the plague. It is always worth while to rub over the contiguous edges with emery-paper to ensure that they may be clean, and, of course, to remove any enamel, etc., from these points of contact.

It has already been suggested that tinned steel plate—to put it brutally, common or garden so-called tin—is quite suitable for these containers, especially if it is nicely finished. The cover should be made of a sufficiently heavy gauge to be self-supporting and rigid, but the base may well be of lighter material, as a number of holes are drilled through it—and through the ¼in. plywood sheet serving as a backing to it.

The Problem of Waveband Switching.

With the exception of the condenser dials already mentioned, no other non-standard components are needed beyond simple control devices for operating wave-changing switches, where they form part of the design. It might seem possible to mount them in the conventional manner on the front panel of the wooden base, but a moment's thought will show that this would not be sound practice; it would be illogical to take extreme precautions to isolate the various circuits and then to lead " danger " wires out from the interior of the screen. Instead of doing this, the switches should be mounted inside the screening boxes with their operating knobs or levers projecting into the base compartment. Where two or three separate switches are used, they may be coupled together as shown in the accompanying illustrations, which show simple methods of dealing with lever or rotary types. In the case of the first, a slot is cut in each metal knob, in which is pinned a link of strip brass terminating in a knob projecting through the side of the base. Knob switches are linked in a similar manner; existing pointers may be made to serve as radius arms. Needless to say, these are improvisations applicable to existing commercial



This view reveals the method of mounting the variable condensers while the removable top gives unimpeded access to all components.

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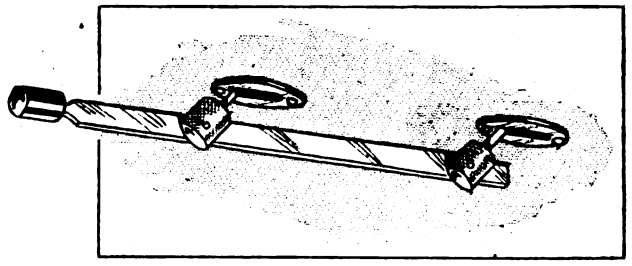
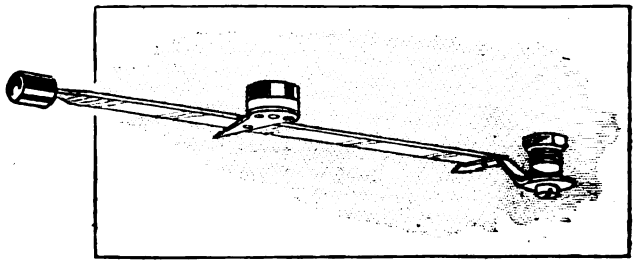
More about Metal Cabinets.—

patterns; they are satisfactory enough in practice, but it is possible to devise other methods of greater mechanical soundness.

Emphasis has already been laid on the accessibility of a set constructed in this manner. This is a point to which all too little attention has been paid in the past, to the intense annoyance of those of us whose hands do not conform to the ideals of the lady novelist. By taking reasonable care in the disposition of components, both in the trays and in the base, it is easy to ensure that all their terminals are within easy reach, either during the initial wiring process or for subsequent alterations and experimental work.



Lever switches fitted to the underside of the baseboard. A link is fitted for simultaneous operation; the control knob projects through the side of the base.



Simple method of linking together two rotary switches of different patterns.

THE DECIBEL.

Introducing a New Unit of Stage Gain.

IN describing the amplification provided by a valve and its associated coupling, the most obvious and most fundamental mode of numerical expression is to say that the stage amplifies " so many times." On account of the extreme simplicity of describing stage gain in this way, it is probable that it is a method which will never drop out of use entirely, especially as it has certain quite definite advantages in its favour. It lends a great simplicity, for example, to estimating the grid bias that will be required for any given valve in a receiver, for if we know that the output valve takes 20 volts of grid bias, and that the stage before it amplifies 20 times, it is not very difficult to see that this penultimate valve will be called upon to handle a maximum of one volt, and so will be satisfied with one volt of grid bias.

Relative Amplification.

For other purposes, and especially in connection with measurements of various kinds, this simple expression of stage gain is not quite all that could be desired. If we plot the amplification-frequency characteristic of a stage of low-frequency amplification, obtaining a curve of the type published by the makers of low-frequency transformers, a unit of different type gives a more informative curve. The ear, as everyone knows, does not appreciate changes in *absolute* but in *relative* sound level, so that a variation of amplification (as between two different notes) from 60 times to 40 times would represent an aural effect exactly equivalent to a variation from 30 times to 20 times, for in both cases the second figure is two-thirds of the first. Plotted as " stage gain," the drop of the curve from 60 to 40 would occupy just twice as much vertical space as the drop from 30 to 20—which is absurd, seeing that the two drops sound exactly alike to the ear. Clearly, to fit such a case as this we need to introduce a new unit in which drops in the curve of equal *relative* magnitude occupy the same space; this can be done by basing the vertical scale on the *logarithm* of the stage gain instead of on the stage gain itself.

There are a number of possible ways of doing this, all of which would give the same curve, but which would differ in the units marked along the vertical scale. To attain uniformity in this respect it has been found necessary to specify the exact method in which the logarithmic units should be chosen, and of the proposals that have been made the one that has so far achieved the widest popularity is the " transmission unit." This is twenty times the logarithm, as found in the ordinary tables used to simplify arithmetic, of the stage gain. Reverting to the example already given, stage gains of 60, 40, 30 and 20 correspond to 35.56, 32.04, 29.54 and 26.02 transmission units respectively. The difference between 35.56 and 32.04 is 3.52, and that between 29.54 and 26.02 is also 3.52, showing that the requirement that equal percentage changes in amplification should correspond with equal changes in the height of the curve has been met.

It has long been felt that " transmission unit " is a clumsy, and even in some cases a misleading name, and the unit has recently been re-christened the *decibel*. The prefix " deci " implies that it is one-tenth of a larger unit, the Bel, so named in honour of Graham Bell, the inventor of the original Bell telephone. A stage gain of one Bel corresponds to an amplification of 3.16 times, or to an increase in power output of 10 times, while a stage gain of one decibel corresponds to an amplification of 1.122 times, or to an increase in power output of 1.259 times. These figures are the tenth roots of those corresponding to the Bel.

It is not difficult to show that in many other directions the decibel offers very considerable advantages over the simple numerical value of the voltage or power ratios involved.

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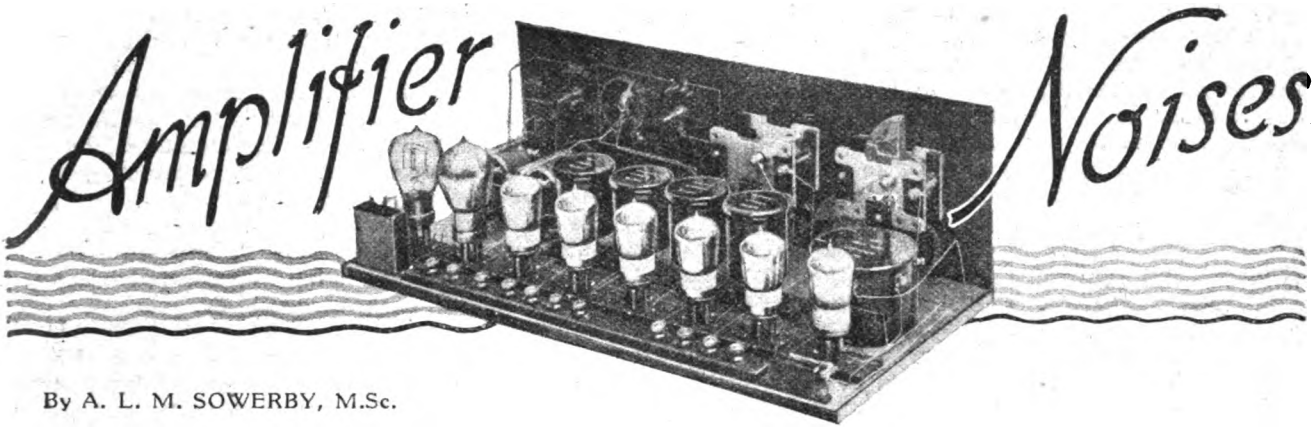
Amplifier Noises



By A. L. M. SOWERBY, M.Sc.

Setting a Limit to Long-Distance Frame-Aerial Reception.

THE craze for portable receivers that is evident at the present day, more especially among those with no technical knowledge, has led many to look into the possibilities of reception on a frame aerial or other small-sized collector of energy. It is self-evident that if a frame or a short indoor aerial is used the signal-voltage available at the input end of the high-frequency amplifier will be much smaller than that which can be derived from a large open aerial, with the result that the sensitivity of the receiver has to be increased to a considerable extent to recover the signal strength sacrificed to the convenience of the small aerial.

When reception is limited to two or three stations, and these the ones best heard at the listener's location, the increase in the sensitivity of the receiver brings no appreciable disadvantage in its train, while in the immediate neighbourhood of a powerful transmitter the extra selectivity conferred by the conjunction of a small aerial and an extra tuned circuit or two in the receiver is of the greatest possible value. But if the listener's ambitions are greater and he wishes to be able to receive any station that is worth hearing, he is compelled, if he wishes to keep to his tiny aerial, to use a still more sensitive set, and he then begins to find that the process of cutting down the received signal voltage and then compensating by higher amplification is one that, though satisfactory enough up to a point, cannot be carried on indefinitely.

"Signal-mush" Ratio.

Those who have built for themselves amplifiers of really high sensitivity will not need to be told that there is a limit to the amount of amplification that can profitably be used in radio reception, but those who have not made experiments on these lines will perhaps wonder how the limit arises, and to what it is due.

If, for example, one sets up a powerful high-frequency amplifier containing perhaps three stages of reasonably good efficiency, one may expect signals to be amplified some 30,000 or 40,000 times at least before reaching the detector. The writer has played about a good deal with a receiver of this kind, and in common with many others has found that when such a receiver is worked "all out" on a very faint station there are subsidiary noises which are nearly as loud as the signal being received. These noises take the form of a loud rushing sound, as of many waters, and this is commonly punctuated at intervals with bangs and cracks of the most violent description. It is usual to refer to the continuous rushing sound as "mush," and to assume that it is picked up, along with the signal being received, by the aerial, and so delivered, after considerable amplification, to the detector valve.

Noises Originating in the Valves.

This explanation of background noise, like most other simple explanations, proves on closer investigation to be true in part, and in part entirely wrong. If one tunes in a station that is received strongly enough to enable the set to be worked at much less than its maximum amplification, it is found that both the continuous background noise and the intermittent louder noises are present, though the signals drown them out fairly completely. Suppose now that the aerial coupling is progressively loosened by some device or other, while a compensating adjustment is made to the sensitivity of the receiver—by control of the filaments of the H.F. valves, for example—so that the intensity of the signals remains unaltered while the input to the receiver is continuously decreased. It is then found that the intermittent loud noises remain at about the same strength throughout the process, showing that they are collected by the aerial at the same time as the signals. The continuous part of the background noise, on the other hand, is found *to grow steadily as the amplification of the receiver is increased.* If this noise also were being picked up by the aerial the increase in amplification would be exactly compensated by the decrease in input brought about by loosening the aerial coupling, since the volume of speech or music from the station to which the set is tuned has been kept at a steady level throughout. One can only assume, therefore, that the rushing sound is not picked up by the aerial after all, but originates elsewhere—and a moment's thought will indicate that the receiver

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itself must be responsible for this particular contribution to the total of noise.

That valves give rise to unwanted noise is not a new discovery, but it is not quite so generally realised as one might expect that the practical limit of amplification is set so low that at least in some unfavourable locations it is simply not possible to receive cleanly on a frame aerial any station other than the local and 5GB.

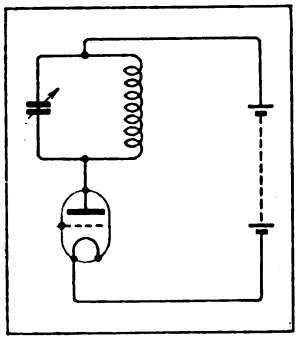

Fig. 1.—The arrival of each electron at the plate "shocks" the tuned circuit into oscillation. The total "shot-voltage" is the resultant of all the oscillations due to the separate electrons.

The writer lives in a London flat, which is believed to be something of a "blind spot," and it is found there that while 5GB can be received with a background of almost perfect silence when a short indoor aerial is used, there is an appreciable amount of background noise when a 2ft. frame is substituted. If an ordinary tuning-coil of 3in. diameter replaces the frame, and signals are brought up again to their normal strength, the background noise rises to a full-throated roar through which music is heard but dimly, while speech is so completely drowned out as to be almost unintelligible. This example of an actual experiment, described while it is fresh in the writer's memory, may help to drive home the unwelcome fact that 'amplifier noises" constitute a very serious limitation indeed to the reception of distant stations on a small aerial.

Having made the unwelcome discovery that these amplifier noises exist, one is immediately faced with the difficult problem of finding some means by which the interruption due to this cause can be brought down to the irreducible minimum. Before we can hope to do this we must find the cause of the noise, and the factors upon which its magnitude depends.

The "Shot-effect."

The source of noise within an amplifier is not a mystery, but is quite well known. It was pointed out some years ago by W. Schottky that the emission of electrons from a heated filament could not, from the nature of the case, be a perfectly steady process, but must be subject to small random variations from moment to moment. As these electrons provide the plate current of the valve, this must also vary slightly about its mean value. These fluctuations would be far too small to be observable on any instrument that could be used to read the plate current, and the smaller fluctuations, at all events, would be too rapid to be followed by the needle of any instrument.

Electrons are emitted from a filament by a process roughly analogous to the boiling of water, and anyone who cares to watch a saucepan of rapidly boiling water will quickly realise that although, in the main, the flow of steam is steady, yet the number of bubbles arriving at the surface varies from moment to moment. Although the number of electrons leaving the filament of a valve is incomparably greater than the number of bubbles of steam in the crude analogy just suggested, yet this is to a great extent offset by the minute fraction of a second—a millionth, or less—which is the unit of time in wireless reception where the incoming waves have a time-period of that order.

The anode current of a valve, therefore, is not to be regarded as due to the steady drift of an "electric fluid" through the valve, but as the sum-total of the shocks resulting from the arrival at the anode of a perpetual stream of electrons, which pepper it like a bombardment from thousands of independently fired shotguns. Since the variations arise from the fact that the current is carried by these separate shots, and not as a continuous flow, Schottky christened the variations the "shot-effect."

Noise Arising at the First Valve.

If a tuned circuit is connected to the anode of a valve, as in Fig. 1, the shocks due to these minute instantaneous variations in the plate current will start oscillations in that circuit at the frequency to which it is tuned, just as atmospherics "kick" an aerial into momentary oscillation. If the tuned circuit is in the plate circuit of the first valve of an amplifier, these oscillations are magnified up along with the signals by the succeeding stages, as shown in Fig. 2, and result, after rectification,

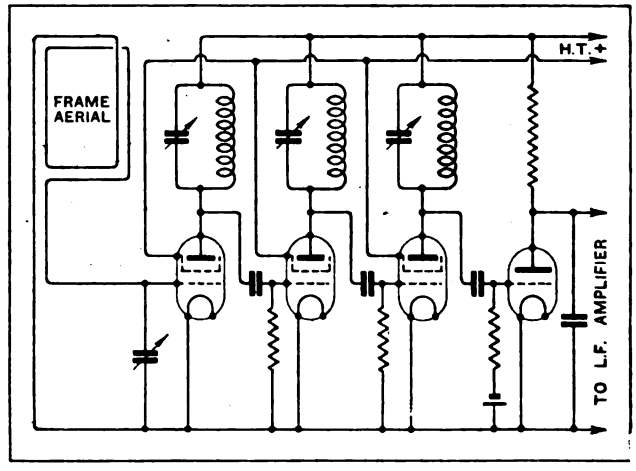

Fig. 2.—In such a receiver as this, the minute voltages due to "shot-effect" set up across the plate-circuit of the first valve are amplified by the remaining valves, and so are enabled to contribute a loud background noise.

in the toneless, rushing sound of which we have already made mention as "amplifier noise."

Later valves than the first also contribute their share of noise, in exactly the same way, but since the noise to which they give rise has to pass through fewer stages of amplification it causes but small disturbance in comparison. From the point of view of practical receiver design, therefore, we will restrict ourselves to considering the noise introduced by the shot-effect in the first valve.

So far we have discussed the shot-effect from a purely

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qualitative point of view, and have gained only the vaguest idea of the probable magnitude of the resulting disturbances. For experimental figures of direct measurement of the shot-voltages developed across the tuned circuit of Fig. 1 we are indebted to Hull and Williams (*Physical Review*, 1925, p. 147). These experimenters embarked upon their measurements with the aim of developing a new and accurate method for determining the magnitude of the negative electric charge by each individual electron, comparing for this purpose the calculated magnitude of the shot-voltage, which involves for its numerical evaluation a knowledge of this charge, with those measured in the laboratory.

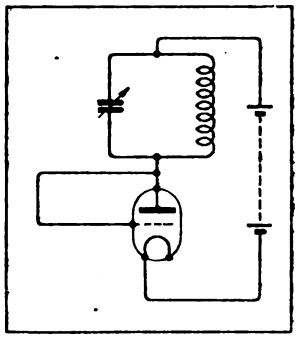

Fig. 3.—The circuit employed in making experimental measurements of the "shot-voltage." The effect is greater in this circuit than in an ordinary receiver.

For this purpose it was necessary for them to make their measurements under conditions which fitted in with those assumed in making the theoretical deduction of the shot-voltage, and one of these conditions was that all the electrons emitted from the filament should arrive at the plate. To ensure this they joined grid and plate of the valve together and connected both, through a tuned circuit, to "H.T.+," as shown in Fig. 3.

If the valve is connected in a more normal manner, with a small negative potential on the grid, some only of the total number of electrons emitted from the filament arrive at the plate, the remainder returning to the filament. Between the moment of their emission and the time when they return they form a kind of cloud round the filament (the "space-charge") and all the electrons that make up the plate current have to pass through this cloud on their way to the plate. As a result of this the fluctuation of plate current is smaller than the fluctuation in the number of electrons emitted, since some of these fluctuations are taken up in varying the density of the electron-cloud. In other words, the shot-voltage across the tuned circuit will not be so great as in the simpler case of Fig. 3.

A Value for "Shot-voltage."

Unfortunately for those who wish to apply the work of Hull and Williams to receiver-design, their measurements were primarily directed towards the evaluation of the charge on the electron, with the result that the effect of space-charge was not investigated very fully, and an exact prediction of the shot-voltage to be encountered in an amplifier cannot be made from their figures. Their measurements indicate, however, that one will be reasonably safe in assuming that a shot-voltage of the order of 250 microvolts will arise across any normal tuned circuit used to couple the first valve to the next.

Now 250 microvolts—one four-thousandth of a volt—does not seem a very large figure, but it must not be forgotten that we are discussing the problem as it arises in connection with highly sensitive receivers, where even so small a voltage as this is likely to be amplified into audibility. If the noise due to shot-effect is not to be great enough to cause serious annoyance, the minimum requirement is that it should at no time be louder than the signals, and on the basis of this very modest demand, together with the figure of 250 microvolts already mentioned, we will try to make an estimate of the minimum signal voltage that must be present in the plate-circuit of the first valve to ensure reasonably noise-free reception.

Relationship Between Signal and Noise.

In Fig. 4 the valve shown represents the first of two or more high-frequency amplifiers in a set working from a frame aerial. Across the tuned circuit LC there will arise a high-frequency shot-voltage of some 250 microvolts. This high-frequency voltage, since the oscillations start and stop intermittently, must be regarded as fully modulated, so that it contributes the maximum of noise after rectification. The same overall signal voltage, even in the loudest passages, would provide a little less noise, since the modulation from a transmitter seldom reaches the theoretical maximum. If we make the condition that the noise due to the shot-effect shall be the same as that due to signals at a moment when the carrier is modulated to the extent of one per cent. (quiet passages in music) we shall require a signal voltage, measured on the carrier, of one hundred times 250 microvolts, or 25 millivolts, across the tuned circuit.

Provided we can attain this minimum signal-voltage, it does not matter in the least whether we follow the valve shown in the figure with a modest receiver ending in a general-purpose valve and a pair of telephones, or whether we put on another couple of valves and

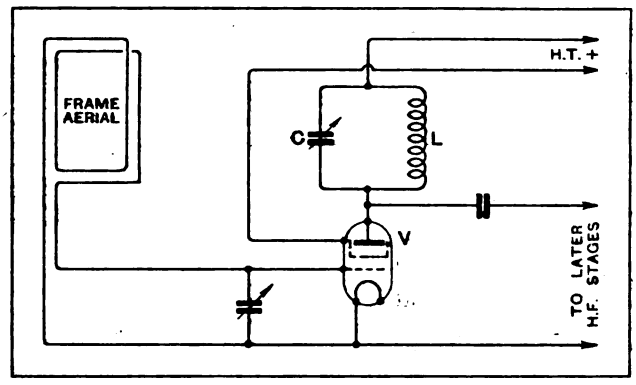

Fig. 4.—The "shot-effect" arises in the tuned circuit LC. For noise-free reception it is essential that the signal-voltage across LC due to the station being received shall be large compared with the "shot-voltage." This can only be done by making the frame aerial highly efficient and choosing the valve V with care.

end up with a moving-coil speaker that nearly lifts the roof. The conditions obtaining in the tuned circuit LC settle, once for all, the ratio between signal strength and noise, and the amplification that may follow can do nothing to improve, and but little to worsen it.

It will be seen that if we accept the figure of 25

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millivolts as the minimum signal strength in LC that will give us reception worth listening to, the bulk of the design of the rest of the receiver follows at once. If, for example, we propose to use a detector which requires 1 volt high-frequency input, we can use no more than 40 times amplification between LC and the detector. More amplification would enable us to receive weaker stations, it is true, but they would be of no entertainment value on account of the noisy background. We should therefore follow LC with a single screen grid valve, coupling it to the detector with a coil of rather high losses so as to keep amplification down to the required figure, to simplify tuning, and to ensure the retention of side-bands.

In estimating the shot-voltage in LC a normal high-efficiency coil was assumed, so that the amplification given by the first valve of the receiver would be some 80 times if a good screen-grid valve were chosen. To obtain the minimum signal voltage of 25 millivolts on LC, we shall therefore require in the frame a voltage of not less than 300 microvolts, and no station which does not induce as great a voltage as this will be heard clear of amplifier noises. In this way a fairly definite limit is set to the possibility of distant reception on a frame aerial by the amplifier of Fig. 4, for the use of more amplification than is required to reproduce a 300-microvolt signal at full strength will not make fainter signals either pleasanter to listen to or more intelligible. Using a normal frame, a field-strength of some 20 microvolts per metre will produce the minimum of 300 microvolts on the frame, so that no station giving a lesser field-strength than this will be worth hearing with the apparatus described.

Although the ratio of carrier-voltage to shot-voltage in the tuned circuit LC should not fall below 100: 1 for satisfactory reception, it need not be concluded that the field-strength mentioned is necessarily quite the lowest from which good reception can be derived. Even apart from the considerable uncertainty of the basic assumption of 250 microvolts for the shot-voltage, the limiting ratio of 100: 1 that has been taken is to a large extent arbitrary, and could only be fixed with any certainty by extensive experiment. In addition, increased size or improved design of the frame aerial would result in obtaining the minimum input-voltage from more distant stations, while the use of a specially chosen first valve, by providing greater amplification, would enable the minimum signal-voltage across LC to be attained with smaller inputs from the frame.

TRANSMITTERS' NOTES AND QUERIES.

New Ceylon Calls.

A wholesale revision has occurred in the amateur call-signs of Ceylon, all of which are now given the prefix VS. The new calls are as follow :—

VS 7AA (ex 1VX), **VS 7AB** (ex 2VX), **VS 7AC** (ex 3VX), **VS 7AD** (ex 4VX), **VS 7AF** (ex 6VX), **VS 7AG** (ex 7VX), **VS 7AH** (ex 8VX), **VS 7AI** (ex 9VX), **VS 7AJ** (ex 1VY), **VS 7AK** (ex 2VY), **VS 7AL** (ex 3VY), **VS 7AM** (ex 4VY), **VS 7AP** (ex 5VX).

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Calling from Cape Town.

Mr. E. R. Cook (G 6UO), who is now in Cape Town for a year's stay, hopes to install a short-wave transmitter in his new quarters to communicate with his friends in Britain. He will retain his English call-sign.

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G2BY Asks for Reports.

Tests on the 20 metre band are being conducted by Mr. H. E. Whatley, 37, Paddenswick Road, Hammersmith, London, W.6, who has been allotted the call-sign G2BY. An LS5A valve is used with an input of 10 watts in a TP, TG circuit. Reports will be welcomed.

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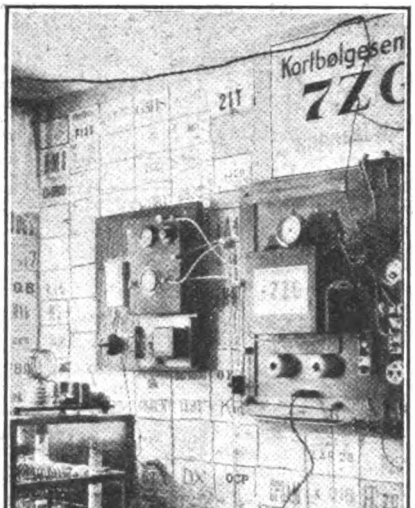
A Correction.

Mr. T. M. Yule's temporary call-sign while with the Anglo-American Corporation at N'changa Mines, Ltd., N'dola, Northern Rhodesia, is VQ 2NC, and not VQ 2ND as stated in error on page 6 of our issue of July 3rd. He sends out the call "Test G" on 41.5 metres every Wednesday at 1700 G.M.T., and then stands by for English stations. He welcomes reports from Great Britain.

DANISH SIGNALS FROM MALAYA.



EN ROUTE FOR SUMATRA. The apparatus of Danish 7ZG, now OZ7Z, which is being taken to Sumatra by its owner, Mr. H. T. Petersen, of Nørresundby, who hopes to be transmitting in the near future with a PK call.

G 6MS Resumes Transmissions.

Mr. A. H. Mason, 30, Marlborough Road, Cathcart, Glasgow, who has lately been abroad, asks us to state that he has now resumed transmissions on 21, 42, and 168 metres.

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Call-signs and Stations Identified.

GREAT BRITAIN.

G2AF	(ex 5XW), C. Bryant, 5, Creffield Rd., Colchester, Essex.
G2BY	H. E. Whatley, 37, Paddenswick Rd., Hammersmith, London, W.6.
G2CG	J. B. Morton, 3, Ashfield Rd., Altrincham, Cheshire.
G2DT	E. T. Somerset, Inholmes Park, Burgess Hill, Sussex.
G2DW	B. Wickham, "Osmonde," Woodstock Rd., St. Albans, Herts.
G2DZ	B. Hall, 25, Coombe Gardens, New Malden, Surrey.
G2FV	W. Scott Hay, 38, Netherlee Rd., Cathcart, Glasgow.
G2NF	G. S. Whale, North Wales Wireless College, East Parade, Colwyn Bay.
G2WP	Cancelled.
G2ZL	H. W. Haydon, 158, Bristol Rd., Gloucester (transmits on 170 metres). Return to original address.
G5QA	H. A. Bartlett, 9, Springfield Rd., St. James, Exeter.
G5RV	R. L. Varney, 12, Hall St., Moulsham, Chelmsford, Essex.
G6HJ	Cancelled.
G6NM	(Portable), North Middlesex Radio Society, "Endcliffe," 7a, Station Rd., Winchmore Hill, N.21. Hon. Sec., H. Laister.
G6ZS	C. Grundy, 334, Rishton Lane, Bolton.
2ABQ	W. Lucas, 64, Worsley Rd., Winton, Patricroft.
2AWT	S. Rees, 39, Brynhyfryd, Aberbeeg, Mon.
2BHI	G. Russell Lee, 25, Boundary Rd., West Kirby, Cheshire.
2BVL	A. E. Brookes, "Cleve House," Cleve Woods, Downend, Bristol.

INDIA.

VU2DG	J. R. Armstrong, 4th Q.O. Hussars, Meerut, U.P.

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CURRENT TOPICS

Events of the Week in Brief Review.

"TALKIES" IN FRANCE.

"Radio-Cinema" is the title of a subsidiary company formed by the Compagnie Générale de T.S.F. for the production of talking film apparatus in France.

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DECLINE OF THE PIANO.

An American journalist deplores the fact that radio is threatening the popularity of the piano—"the only hiding place for drinks that the police never dream of searching."

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FRENCH WAVELENGTH ECONOMY.

Radio-Paris has headed the list in a ballot organised by *L'Antenne* to discover which stations should escape the wavelength economy axe. It is contended that if the Prague Plan is to be a success in France a number of stations must be scrapped.

Other broadcasters which came high in the list of favourites were Radio-Toulouse, Eiffel Tower and Radio-Lyons.

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THE SHORT-WAVE LINK.

A licence for a portable short-wave transmitter for use in boats, 'planes and other movable objects is being sought by the American National Broadcasting Company, writes a New York correspondent. The company has applied to the Federal Radio Commission for a construction permit and a station licence in New York.

In previous broadcasts from 'planes and boats and other points where direct wire connections were impossible the N.B.C. has co-operated with organisations licensed to operate portable transmitters.

It is interesting to recall that the B.B.C. operated its own short-wave transmitter for outside broadcasts as far back as 1924, when the famous wireless-equipped "perambulator" was taken to the Zoological Gardens, animal noises being transmitted to headquarters on a secret wavelength and rebroadcast from 2LO.

THE £40 AERIAL.

The Lyons civil tribunal has ordered a landlord to pay a fine and damages amounting for £40 for destroying his tenant's aerial with an axe.

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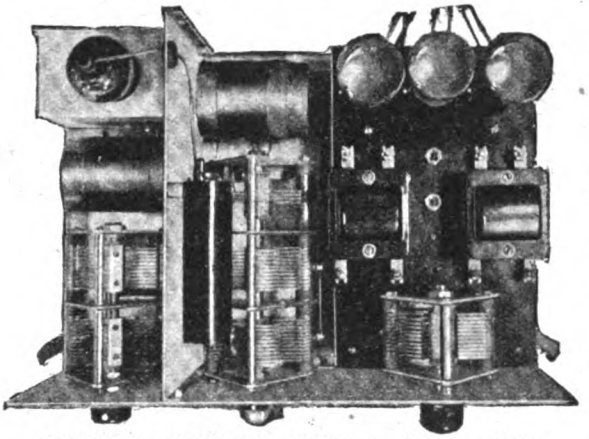
BIG STATION FOR CZECHOSLOVAKIA.

A site for Czechoslovakia's newest and biggest broadcasting station has been fixed upon near Cesky Brod, twenty-one miles from Prague, says the *Central European Observer*. Test transmissions, with mobile equipment, will probably be carried out in the near future.



AUSTRALIA—ENGLAND FLIGHT. The specially-constructed receiver used by Captain Kingsford Smith and his companions on the "Southern Cross."

RADIO TELEPHONY WITH THE EMPIRE.

Following on the recent announcement by Mr. Kellaway, formerly Postmaster-General, that a successful telephone conversation had been conducted by wireless between Australia and England, it was stated at the General Post Office that negotiations were already in progress with the Australian Government for the establishment of a regular telephonic service between the two countries.

It is probable that future tests may be extended to include South Africa and other Dominions.

U.S. RADIO INVADES FRANCE.

Several important American firms will display apparatus at the Paris International Wireless Exhibition, to be held from September 27th to October 13th.

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LOUD SPEAKER MUZZLING ORDER.

Southend Corporation has adopted a bylaw prohibiting the use of loud speakers in streets and other public places.

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TAXI WIRELESS.

Several London taxicab firms, we understand have obtained permission to equip their vehicles with experimental short-wave sets to enable traffic directions to be received from headquarters.

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WIRELESS ON "SOUTHERN CROSS" FLIGHT.

In their recent successful flight from Australia to England in the "Southern Cross," Captain Kingsford Smith and his companions carried a wireless receiver specially constructed in Australia and equipped with Osram valves, viz., one S215, two DEL410 and one DEP410. The operator, Mr. McWilliams, received messages throughout the flight, and was able to give the pilots valuable data regarding atmospheric and landing conditions ahead. In order that no source of information should go untapped, the receiver covered a wavelength range from 18 to 2,700 metres.

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MAN-MADE STATIC IN GERMANY.

Protests from listeners have provoked a declaration by the German broadcasting authorities that no legislation exists at present forbidding the sale of electrical apparatus such as ultra-violet ray machines, carpet sweepers, etc., which causes interference to broadcast reception. It is urged that the remedy lies in the hands of the public, who should insist on manufacturers supplying apparatus which is incapable of setting up disturbance.

NEXT WEEK.—A selective four-valve receiver for noise-free long-range reception.

THE FOREIGN LISTENER'S FOUR.

Summarising its merits, this set is easy to build and possesses a degree of selectivity that will permit of the cutting out of the local station at short range giving loud speaker foreign station reception. It is free from valve noise and in no circumstances will the constructor encounter oscillation troubles. New valves of remarkable performance are incorporated and combined with new ideas. The cost for all components is about £12. Operating entirely from A.C. supply it includes an eliminator so that neither batteries nor grid cells are required. Programmes from practically any European station can be followed with almost the same ease that is experienced when listening to a local station.

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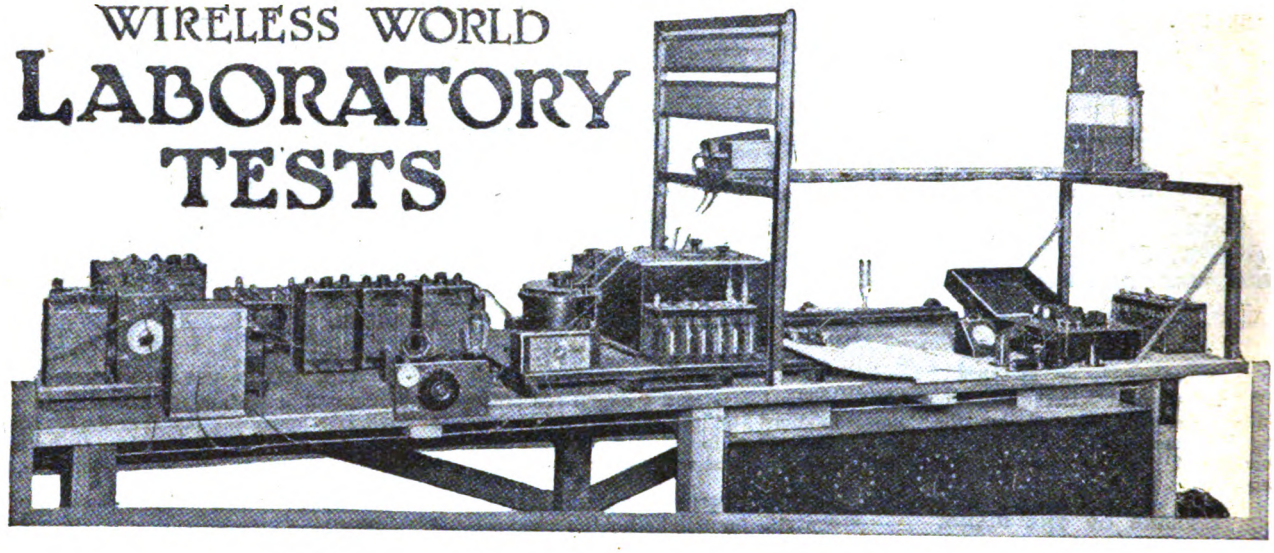
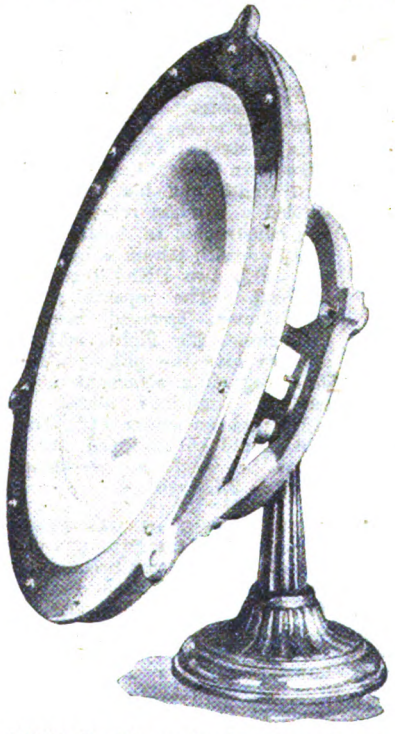
WIRELESS WORLD LABORATORY TESTS



A Review of Manufacturers' Recent Products.

"WHITE SPOT" CONE CHASSIS.

The "White Spot" cone chassis has been designed especially for use with the well-known "Blue Spot" loud speaker unit and is supplied either complete with diaphragm or as a skeleton frame only. The method of mounting the cone follows moving-coil practice in that a supple leather surround is employed. This is stretched tight and the cone carefully centred.



"White Spot" cone loud speaker chassis fitted with stand.

The chassis consists of a clean aluminium casting with an adjustable back plate for holding the unit, and a polished front ring provided with lugs for fixing to a baffle or in a cabinet. Although not essential, a baffle, or its equivalent, is desirable, as it is instrumental in bringing out the very low notes.

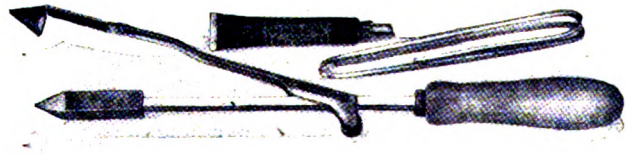
The chassis is available in three models: the "Popular," fitted with a fabric suspended cone at 16s.; the "Super," with gold-finished fabric suspension at 18s. 6d.; and a specially designed model for portable sets at 10s. 6d. Cast-iron stands for the "Popular" and "Super" models cost 2s. 6d. each.

The makers are the Wolverhampton Die Casting Co., Great Hampton Street, Wolverhampton.

"JUNIT" SOLDERING OUTFIT.

This consists of a soldering iron, a tube of non-corrosive flux, and a stick of solder, the outfit costing 4s. only. The main feature of interest lies in the soldering iron since the business end is indirectly heated and cannot, therefore, lose its "tinning." The copper bit is provided with a loose tinned copper cap, which is removed when the iron is placed in the fire. The cap, not coming in direct contact with the flame, will not require continual attention; it is certainly a labour-saving device, and should find a strong appeal among amateur constructors.

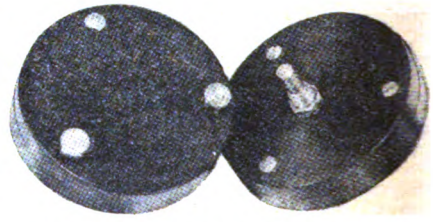
The makers are the Junit Manufacturing Co., Ltd., 2, Ravenscourt Square, London, W.6.



Junit soldering outfit including "Peerpoint" iron with removable cap.

"MICROFICIENT" VARIABLE CONDENSERS.

The main feature of these variable condensers is that a material resembling thin paxolin sheet is employed as the dielectric. Since the plates need not be self-supporting, thin brass foil is used; consequently the size, as regards depth from back to front, has been reduced to seemingly absurd proportions when compared with one of the usual type having air-spaced vanes.



"Microficient" variable condenser with brass foil plates and paxolin dielectric. A Graham Farish product.

The condenser is housed in a neat moulded bakelite case measuring 3in. in diameter and ⅝in. in depth. A single hole fixing bush is fitted. Two samples were submitted for test, namely, a 0.0005 mfd. and a 0.0003 mfd. capacity. The measured values were found to be 8 micro-mfds. minimum and 0.000753 mfd. maximum for the 0.0005 mfd. size, and 6 micro-mfds. minimum and 0.000281 mfd. maximum for the 0.0003 mfd. size. The plates are shaped, it is claimed, to follow a logarithmic law.

The makers are Messrs. Graham Farish, Ltd., Bromley, Kent, and the price has been fixed at 4s. 6d. for the 0.0005 mfd. size and 4s. 3d. for the 0.0003 mfd and 0.00015 mfd. sizes.

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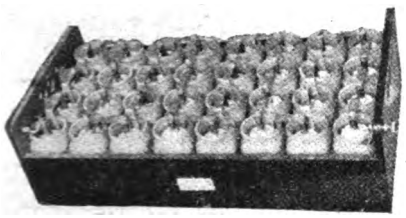
"STANDARD" WET H.T. BATTERY.

An H.T. battery consisting of the No. 4 size cells was submitted for test by the Standard Wet Battery Co., 184-188, Shaftesbury Avenue, London,



Tray containing 32 No. 4 size "Standard" cells. Nominal voltage 48.

W.C.2. The container holds 32 cells and gives a nominal voltage of 48. Since these cells are the largest size available and are recommended for use with super-valves, it was decided to commence the discharge test at about 30 mA. During the first few hours the current fell rapidly, but quickly reached a steady state, and thence onward was well maintained for a period of approximately 500 hours.

This represents actual working time, and to reproduce as near as practical considerations would allow the conditions obtaining during use, the battery was discharged for periods of 4 hours, with similar periods to recuperate. The recuperation periods have been omitted from the graph, and the actual working time only plotted. There would appear to be a natural "cut off" after the 500-hour mark is passed, since the current fell rapidly, so that this can be regarded as the useful life of the battery on one charge.

To renew the battery it is necessary to obtain new sacs, zincs, and fresh electrolyte. The jars should be well scoured in hot water before assembling the new parts. The price of the No. 4 size in trays containing 32 cells is £1 17s. 2d. Spare sacs cost 4s. 6d. a dozen, and zincs 1s. 6d. a dozen. Electrolyte chemical is sold in jars, and sufficient for twenty No. 4 size cells costs 2s.

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"EKCO" ALL-POWER UNIT FOR D.C. MAINS.

The model submitted for test is a C2A, which gives H.T., L.T. and grid bias when connected to D.C. mains of between 200 and 250 volts. No alteration whatsoever is required to the set, but the L.T. current consumed must not be less than 0.2 amp. or greater than 0.35 amp. Either 2-, 4-, or 6-volt can be used.

Three H.T. tappings are provided, one giving between 120 and 150 volts, one giving 60 volts nominal, and a tapping marked "SG" for the screen potential of screen-grid valves. In addition, grid bias voltages from 1.5 to 12 volts in five steps are available.

"Ekco" complete battery eliminator for use on D.C. supply mains.

Measurements showed that the marked H.T. voltages were obtained when 15 mA. at 140 volts were drawn from the 120-150-volt tapping and 2.8 mA. from the 60-volt tapping. The voltage available for the screen in the screen-grid valve under these conditions was found to be 70 volts. The current drawn from this tapping was limited to 0.4 mA.

Measurements of the L.T. current gave results sensibly in agreement with the maker's figures, provided suitable adjustments are made to the selector plug located in the base on the underside of the unit.

With the wander plug inserted in No. 1 socket, the maximum current that would pass was found to be 0.26 amp., but in No. 4 socket a current of 0.39 amps became available. Intermediate positions gave maximum outputs of 0.3 amp. and 0.35 amp. respectively. The grid bias voltages were measured and found to be in agreement with the marked values.

A practical test was made using a three-valve set fitted with a small-power output valve. There was slightly more hum than usual with H.T. eliminators, but this was not troublesome. Fastidious listeners, already possessing an L.T. accumulator, can reduce the hum to normal proportions by "floating" this across the L.T. terminals and adjusting the L.T. supply to balance the drain on the accumulator. A practically worn-out battery could be used for this purpose.

The unit is enclosed in a metal case adequately ventilated, and the price has been fixed at £5 17s. 6d. The makers are Messrs. E. K. Cole, Ltd., "Ekco" Works, Leigh-on-Sea, Essex.

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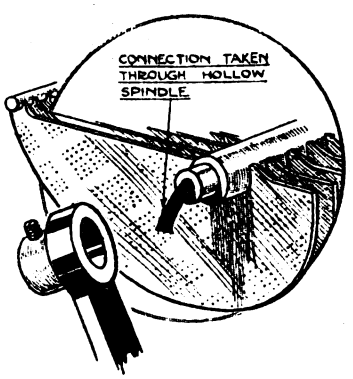
FORMO CONDENSERS.

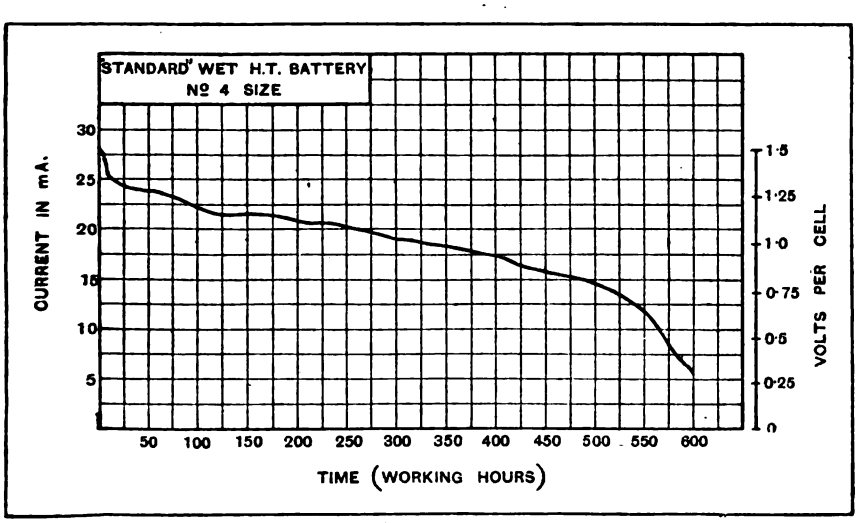
When describing the condenser used in the Formo short wave outfit in the pages devoted to Laboratory Tests,[1] attention was drawn to the absence of a pigtail connector. It was pointed out, nevertheless, that a test revealed silent working. This



Internal braided connector fitted to Formo condensers.

observation may have appeared inconsistent in the absence of the provision of a connector bridging the bearing surfaces. Subsequent examination involving the dismantling of the condenser has revealed a totally enclosed braided connector in the centre spindle passing out to a fixing on the bearing. This method of connection is to be particularly recommended, as it entirely avoids the changes in the constants of a circuit such as may arise with the use of the general form of spiral pigtail. Readers who may have been doubtful as to the suitability of the Formo condenser as the result of a perusal of the recent report will now appreciate that the design adopted is in every way reliable.

[1] July 3rd, 1929, page 17.



Discharge curve of "Standard" wet H.T. battery of No. 4 size cells.

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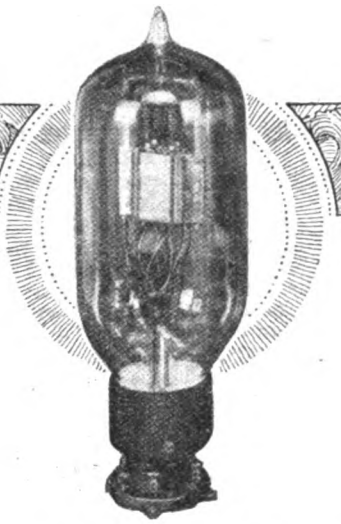
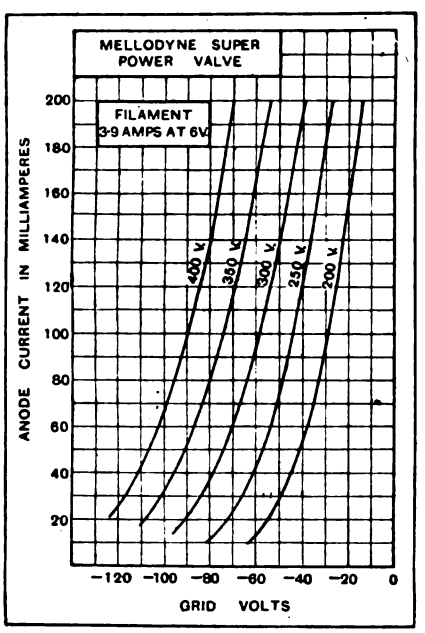
VALVES TESTED



A New Super Power Valve.

THIS is a super-power output valve designed especially for use where a large electrical output is required to operate a number of loud speakers. It is particularly suitable for use in the output position of a public-address amplifier; indeed, in slightly modified form it is being employed in certain amplifying systems in connection with talking films and gramophone reproducing equipment. The main features of the valve are: low A.C. resistance, comparatively high amplification factor, and exceptionally good mutual conductance. Furthermore, it operates without an excessively high anode potential.



Average characteristics under normal working conditions. A.C. resistance, 760 ohms; amplification factor, 33; and mutual conductance, 4.35 mA/volts.

This particular type is made by the North London Valve Co., Ltd., 22½, Cazenove Road, Stoke Newington, London, N.16, for Messrs. Pollock Bros., Royston Works, Putney, London, S.W.15, who have acquired the sole distributing rights. The rated characteristics of the "Mellodyne" are: A.C. resistance, 800 ohms; amplification factor, 3.8; and mutual conductance 4.5 milliamps per volt. This is an exceptionally good conductance for a valve of such low A.C. resistance. The normal working anode potential is 400 volts, and the optimum grid bias is of the order of minus 80 volts.

The construction of the valve differs widely from that generally adopted. Perhaps it can be described best as consisting of four sets of electrodes internally connected in parallel, but with a common anode. The anode is divided into two compartments, however, and in each is assembled two grids and two filaments. The glass envelope measures 6in. high by 3in. in diameter, and the overall height is 8¼in.

The valve is not "gettered," but the required hard vacuum is obtained by pumping for a long period. Each valve is tested finally by running for a definite period with normal H.T. and zero grid bias, and at the end of this it must pass satisfactorily a test for hardness before leaving the works.

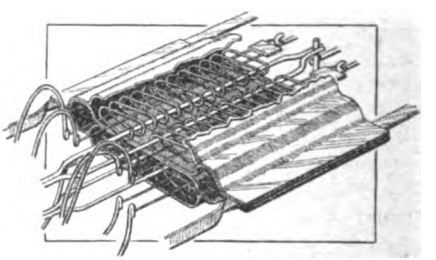
The average characteristics under normal operating conditions of the specimen tested were found to be: A.C. resistance, 760 ohms; amplification factor, 3.3; and mutual conductance, 4.35 mA. per volt. These figures are sensibly in agreement with the maker's rating.

The "Mellodyne."

The following table gives the anode current under various operating conditions:—

H.T.	Grid Bias.	Anode Current.
300 volts	− 60 volts	96 mA.
	− 70 ,,	63 mA.
350 ,,	− 75 ,,	97 mA.
	− 85 ,,	66 mA.
400 ,,	− 80 ,,	140 mA.
	− 90 ,,	100 mA.
	−100 ,,	65 mA.

In view of the low A.C. resistance and, comparatively, high amplification factor, special precautions must be adopted when using this valve. There may be a tendency towards incipient H.F. oscillation at a very high frequency, and should this occur it will be traceable by a big increase in the anode current. Any tendency in this direction can be guarded against by fitting a resistance of a few thousand ohms in series with the grid. It would be advisable to regard this as an essential addition to the circuit, and it should be included as a precautionary measure.



Electrode assembly of the "Mellodyne" super-power valve.

The "Mellodyne" is being offered at £5 10s. A valve of similar construction, but having an A.C. resistance of 1,000 ohms, and amplification factor of 4.6, and a mutual conductance of 4.6 mA. per volt, is available also at the same price, but this particular type, known as "Leo the Lion," is supplied by the North London Valve Co., Ltd.

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KIT CONSTRUCTORS' NOTES

Valve Filament Risks—and Some Safety Precautions.

IN descriptions of kit sets appearing in these pages mention has on more than one occasion been made of the fact that battery wiring is in many cases so arranged that the filaments of all the valves may possibly be burnt out should an accidental short-circuit occur between the positive high-tension lead and earthed metallic screening, etc. The why and wherefore of this state of affairs does not seem to be obvious to many readers, judging from correspondence, and it is thought that a short explanation of the matter, with a word of advice as to how the possibility of an accident may be prevented, will be of interest to many builders of these sets.

It seems that the designers of the sets in question have embarked on their task with the entirely commendable idea of arranging the on-off switch to disconnect both H.T. and L.T. batteries, and have accordingly inserted it in the common negative lead. If we study a theoretical circuit diagram of this form of connection it would at first appear that their object has been satisfactorily achieved, and that the negative pole of the H.T. battery is completely isolated from the set wiring when the switch is "off." At least, this will seem to be so if we draw our diagram in the conventional manner, with terminals for battery connections, but we must not forget that the L.T. cells will be permanently joined to their points of attachment; when the switch is opened the high-tension negative terminal is still connected to the filaments *via* the L.T. battery, which may be regarded as a conductor of negligible resistance.

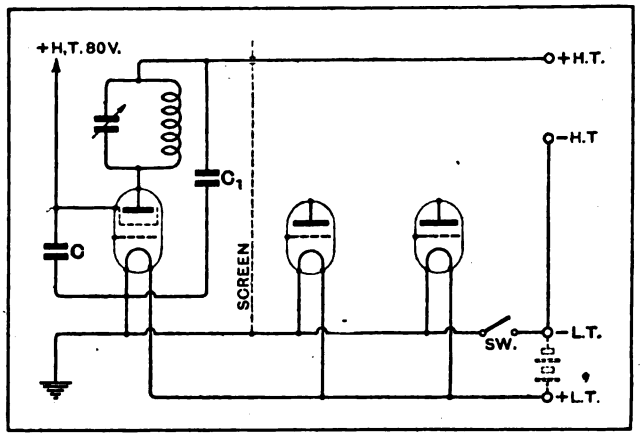

Fig. 1.—Showing how filaments may be damaged by an H.T. short-circuit to earth.

All this will be made clear from a consideration of Fig. 1, in which the filament heating cells are shown in dotted lines. It will be seen that with the switch open H.T. negative is connected to the positive side of all valves, and that an accidental contact between H.T.+ and *any* earthed point—screen, filament bus-bar, individual negative filament wiring, or external earth lead, etc.—will cause the circuit to be completed through the filaments, and, if the high-tension battery has a fairly low internal resistance, the valves will inevitably be burnt out.

It may be said that such short-circuits should not take place, but it is fatally easy to make accidental contact with large metal surfaces, and, even if the operator never makes a mistake, there is a remote possibility that one of the anode by-pass condensers, such as those shown in C and C_1 in the diagram, may develop a short-circuit, or even that the electrodes of the "S.G." valve may make contact. In either case the result will be the same, and one is forced to the conclusion that it is a mistake, or, rather, that it is impossible to make a simple single-pole switch serve the purpose of switching off both batteries. As frequently pointed out in this journal, it is generally safe to keep the H.T. battery permanently connected, because as soon as filaments are extinguished the flow of anode current will automatically stop, provided insulation is adequate—as it should be, in any case.

In many cases the sponsors of kit sets have issued instructions for connecting a flash-lamp fuse; this is satisfactory enough, but the amateur must not fall into the error of thinking that the ordinary lamp, which often carries a current of as much as half an ampere for considerable periods without fusing, will confer complete immunity; it certainly will not do so if only one of the valves is in position in the set, and it may even be inadequate when they are all inserted in their holders. Those who rely on this form of protection should be careful to choose bulbs with a low fusing point, or one of the special fuses designed to "blow" before the current rises to the value normally passed by a valve filament. There are several other ways of ensuring that a high-tension short-circuit will do no more damage than that inevitably caused to the cells through a too-rapid discharge, and it is certainly wise to consider making a minor modification to the switch wiring in the manner shown either in Fig. 2 (*a*) or (*b*). In the first diagram H.T.– and L.T.– are connected externally to their normal terminals, which are joined together internally, and also to the common filament bus-bar and to earth, while the switch is transferred to the L.T. positive lead, being inserted between the input terminal and

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Kit Constructors' Notes.—

the feed leads to the various filaments. This is a form of connection advocated by the majority of contributors to this journal, but it is not possible in cases where a metal panel is used and when the switch is of the type in which one contact is in metallic connection with the panel. In such cases the very simple alteration shown in diagram (*b*) is to be preferred, and it involves no more alteration than can be carried out in a few moments. All we have to do is to remove the connection between the H.T. negative terminal and the L.T. negative terminal, and to join the former directly to the most convenient point on the common negative bus-bar. Either of these alterations confers complete immunity from the possibility of burn-outs in the manner described.

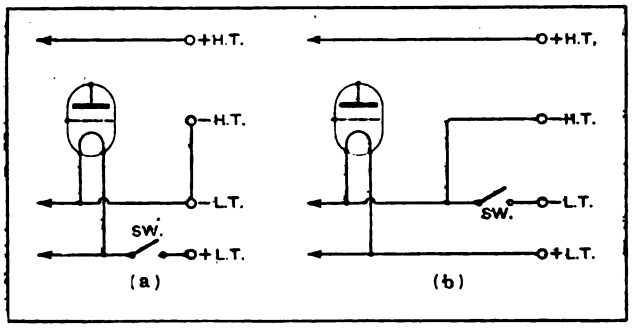

Fig. 2.—Simple alterations in switch wiring.

Those who do not wish to make any alterations to their sets should always remember that when making any experiments or tests involving the remotest possibility of "earthing" an H.T. positive connection it will be wise to set the switch in the "on" position, so that the filaments will be bridged by the L.T. battery, which will automatically prevent any serious rise in the voltage across them.

KIT CONSTRUCTORS' PROBLEMS.

The information Department Service has been extended to deal with problems encountered by builders of "kit" sets discussed in these pages. Receivers already treated are the "New Cossor Melody Maker," Osram "Music Magnet," Mullard "Master Three Star," Six-Sixty "Mystery Receiver," Ferranti "Screened Grid Three," Formo "Screened Grid Three," Dubilier "Toreador Screened Grid Four," McMichael "Screened Three," and the Mullard "S.G.P. Master Three." The service is subject to the rules printed in the "Readers' Problems" section.

Decoupling Precautions.

I am thinking of making an eliminator for my Osram "Music Magnet" set, and should like to know whether it would be an advantage to fit a decoupling resistance in the anode circuit of the detector—or anywhere else, if the addition is likely to do any good. S. V. C.

Although the circuit of this receiver is not particularly prone to L.F. reaction troubles, due largely to the fact that it employs but one L.F. stage, the fact remains that when *any* receiver is supplied with H.T. current from the eliminator, more or less complete isolation of the various circuits is likely to prove advantageous.

As a first step it is a good plan to include a choke filter output (of the type in which one side of the loud speaker is joined to the negative filament bus-bar). This in itself is likely to prove efficacious, but as a further precaution a feed resistance (with its associated by-pass condenser) may be connected in the detector anode circuit.

Lastly, it must not be forgotten that L.F. impulse can be fed back to the detector grid *via* the tuned anode coil, etc., and to be completely safe the plate circuit of the H.F. valve can also be decoupled. From the "L.F." point of view, there is no point in providing a resistance feed for the screening grid, although this addition (with, of course, a by-pass condenser) will certainly do no harm, and will help to ensure stability when the set is operated with maximum anode voltage.

A Hot Bulb.

The pentode valve of my "Mullard S.G.P. Master Three" gets very warm after the set has been in operation for a short time. This rise in temperature can be reduced by increasing negative bias, but quality is then not so good. Is it normal that the valve envelope should become hot? T. M.

Yes, this effect is quite usual, and if the glass bulb does not become uncomfortably hot to the hand you need not be perturbed. We do not consider that there is any need to operate it under conditions other than the best; by increasing negative bias beyond the optimum value you are, in effect, reducing the amount of energy dissipated in the valve, and it is consequently to be expected that the valve will run cooler.

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An Extra Valve.

In order to obtain a larger reserve of amplification (which is often necessary in this remote district) I am thinking of adding a resistance-coupled L.F. amplifier to my "New Cossor Melody Maker." Of course, this coupling will be between the detector and first L.F. valve; will you suggest a suitable value for the anode resistance? F. B. H.

In a case like yours, where a grid circuit detector with reaction is used, we think it is a mistake to use an excessively high value of anode resistance, and in any case there should be little need to strive for the maximum attainable magnification. We suggest a value of something between 50,000 and 100,000 ohms, depending upon the impedance of the detector valve.

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Trouble in the H.F. Amplifier.

My "New Cossor Melody Maker" has worked satisfactorily for some time, giving pleasing quality of reproduction. Lately there has been considerable deterioration in every respect, and quality is distinctly poor; I can best describe it by saying that there is a good deal of "woolliness" and that the upper frequencies seem to be almost entirely lacking. This falling-off in performance is coincident with the need for a good deal of reaction in order to obtain reasonably loud signals; originally the feed back condenser was set at zero for reception of my nearest station. From this information can you tell me what is wrong? H. T. M.

From the information you give we think it extremely probable that the poor reproduction of which you complain is largely, if not altogether, due to excessive use of reaction. The need for this, in turn, would appear to be due to a serious falling-off in the effectiveness of your H.F. amplifier, considered as a whole, and you should look carefully to all the components associated with this part of the receiver, not forgetting the valve itself. Needless to say, you should assure yourself that the voltages applied to filament, anode, and screening grid of the H.F. valve are correct, and, lastly, you would be well advised to look to your aerial-earth system.

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H.T. Current Consumption.

I am thinking of building the "Mullard S.G.P. Master Three." Using the recommended valves in the 6-volt range will you please give me some idea as to the probable total anode consumption of the set? N. P. R.

A good deal depends on the actual H.T. voltages applied to the various anodes and, of course, on the grid bias pressure for the pentode. Current consumption may be reduced by over-biasing this valve and also by applying to its screen a voltage somewhat less than that impressed on the anode, but we do not think that the very best results of which the set is capable will be attained with a total consumption appreciably under 20 milliamperes.

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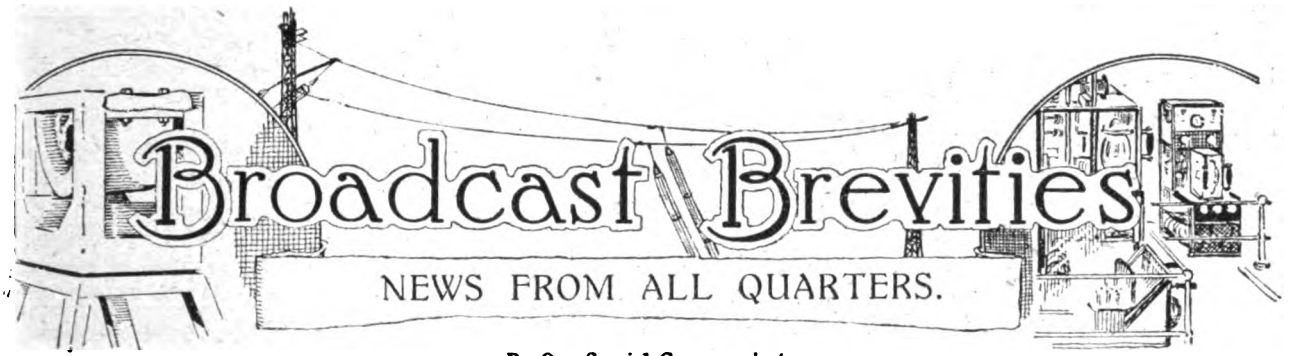

By Our Special Correspondent.

A Champion for Scotland ?—The Television Impasse.—Gramophone "Effects."

A Scottish Governor ?

The B.B.C. Board of Governors has never pretended to represent any part of the country in particular, but in view of the growing dissatisfaction which has been lately expressed in regard to the future of Scottish broadcasting under the Regional Scheme there is a strong probability that before long a new member may take his seat at the Board with the exclusive intention of championing the cause of listeners over the Border.

In this connection the name of Mr. Hugh S. Roberton has been mentioned As conductor of the Glasgow Orpheus Choir, Mr. Roberton is known in most corners of Scotland.

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A Question of Numbers.

No limit is set in the B.B.C.'s Charter to the number of individuals who may comprise the Board of Governors, so that a new appointment or appointments might be made in the twinkling of an eye, and the country might wake up one morning to find that Wales and Northern Ireland were also represented, not to mention the Isle of Man.

"In a multitude of counsellors there is wisdom," runs the proverb, but, like most proverbs, it has an opposite number, relating in this case to a superfluity of cooks. The bigger the governing body at Savoy Hill, the greater the probability that the B.B.C. will develop into a vast Circumlocution Office with a minimum of personal responsibility. If new Governors are to be appointed it would surely be advisable to consider whether they should merely supplement the old or replace them.

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No Television Tests from Brookman's Park.

The breaking off of negotiations between the Baird Television Development Company and the B.B.C. is apparently judged of insufficient importance at Savoy Hill to justify a statement beyond the formula : "We have nothing to say."

It had been expected that television tests would begin immediately upon the opening of the new London Regional station at Brookman's Park at the end of this month, but I gather that the hitch occurred during negotiations concerning a possible contract.

The possibility that the advent of a new Postmaster-General might facilitate television transmissions from an independent station may not have been overlooked. The possibility seems rather remote.

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Noises Off.

One can fully sympathise with the B.B.C. Effects Department in their search for bigger and better noises without necessarily endorsing their latest enterprise in trapping genuine sounds by gramophone records. Mr. Lance Sieveking, who has already exhibited a staggering fecundity of ideas, is the originator of the plan, and proposes to use certain records made at Oxford Circus tube station for a series of "Intimate Snapshots" to be broadcast in the near future.

SUNDAY MORNING NOVELTY. At 7 a.m. on Sundays Hamburg broadcasts a church service, followed by an orchestral concert performed on board one of the ships in the harbour. The Hamburg announcer is here seen on board the "Cap Polonie."

The records are said to have given great satisfaction to the privileged few who have heard them ; if so, they must surely be far superior to any noise records made in the past.

It has generally been conceded that the microphone is kinder to manufactured noises than to sounds which approach the real thing, and if "Intimate Snapshots" are a success they will reveal a surprising advance in gramophone technique.

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Preparing for Bank Holiday.

A special vaudeville programme is being arranged for August Bank Holiday. Among the items already fixed up are the following : A sketch entitled "Where Ignorance is Bliss," with Tommy Handley as compère ; Burns and Allen, probably the best of recent comedy broadcasts ; Teddy Brown ; Stuart Ross and Joe Sargent. On the same evening Gordon McConnel will produce a "light-headed" programme.

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H.R.H. and the Chief Scout.

Speeches by the Prince of Wales and the Chief Scout, Sir Robert Baden-Powell, at the International Jamboree in Arrowe Park, Birkenhead, on August 2nd, will be relayed to 2LO and 5XX at 3.45 p.m.

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"O.B." Van at Tidworth.

From the grounds of Tidworth House, Tidworth, Hants, the Southern Command Tattoo will be relayed to 2LO and 5XX on August 3rd. Listeners will hear Part 1 from 9.30 to 10 o'clock, and Part 2 from 11.10 to 11.50. The greater part of the latter period will be devoted to a "Pageant of the Glorious Past," and will include reminiscences from the Napoleonic period to the Army of to-day.

As at Aldershot, the engineers will make use of the "outside broadcast" van, which contains all the heavy amplifying gear and a studio, and is, in fact, a control point.

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Are Long Plays Appropriate in Summer ?

In veneration for Greek drama in general and the plays of Euripides in particular, I yield place to none. But I doubt whether even the *Electra* kept many listeners indoors for an hour and three-quarters on that blisteringly hot evening of last week. And if it did not, surely the broadcast was a waste of splendid effort ?

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BEHIND THE SCENES AT HENDON.

Wireless and the R.A.F. Display.

IF a fiat had gone forth prohibiting the use of wireless and valve amplification equipment throughout Great Britain on Saturday, July 13th, the R.A.F. Display at Hendon would have lost half its effectiveness. But as no such spiteful edict was issued, it is probably safe to say that the great British public gave

A general view from the roof of the control room, showing the microphone in use.

little thought to the work which was going on in the little operating huts and control rooms behind the scenes. Presumably because wireless is now accepted as a commonplace, the R.A.F. refrained from "starring" the radio events, although radio played almost as big a part on this occasion as in years gone by.

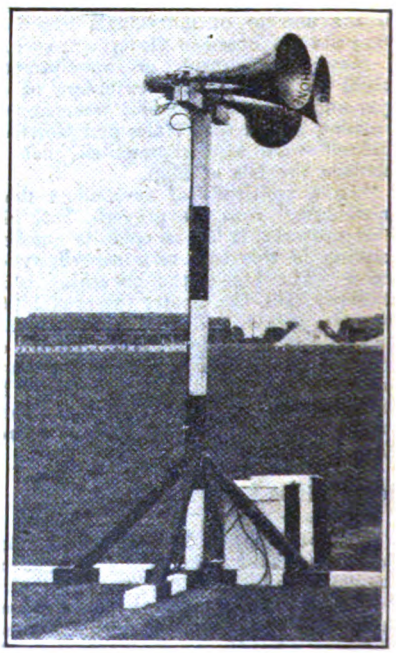
The most convincing demonstration of the value of radiotelephony control in the air occurred at the end of the programme, in the air battle which formed a suitable prelude to the attack on the fortified port. In this event the spectators were allowed to eavesdrop while telephony messages were exchanged between a lone reconnaissance 'plane braving the anti-aircraft fire from the quayside and a distant bombing squadron, which eventually came up in support in response to the wireless appeals. Telephony orders from the commander of the enemy fighter squadron were also received and reproduced for the public benefit.

Picking Up 'Plane Calls.

The messages from the air were picked up by short-wave receiving stations at scattered points outside the aerodrome and were relayed to the central control room, whence they were distributed to nearly sixty Marconiphone loud speakers. Engine noises naturally affected the clarity of the speech, but helped, possibly, by the knowledge that the forces of right would eventually triumph, listeners had no difficulty in gaining an intelligent idea of the progress of the engagement.

Wireless telegraphy, as distinct from telephony, was extensively used for the concentration of air units taking part in the Display, and without its aid, it would have been impossible to time the arrival of many units which arrived at Hendon from various aerodromes just at the moment when they were required.

All records as regards public address systems in this country were eclipsed by the Marconiphone Company at Hendon on July 13th. The public enclosures were adequately "covered" by no fewer than forty-nine 2in. moving-coil loud speakers, in addition to which a number of smaller instruments of the indoor type



Nearly sixty moving-coil loud speakers reproduced band music and kept spectators informed regarding the progress of the Display. Beneath the loud speaker stand can be seen the line of turf covering the buried cables which totalled over twelve miles in length.

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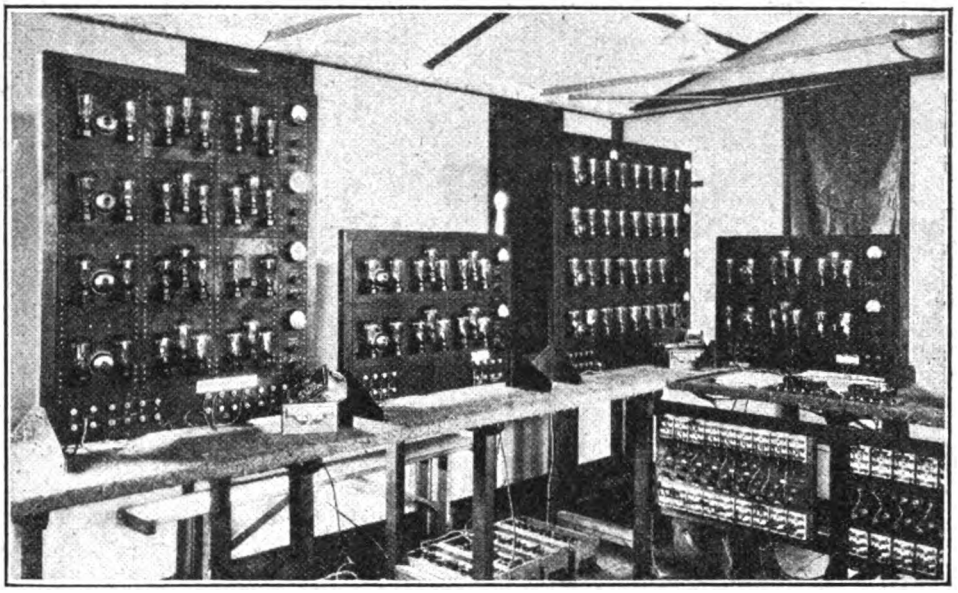
Behind the Scenes at Hendon.—were employed for announcing purposes in the neighbourhood of the Royal Enclosure.

To feed so many loud speakers, nearly 180 valves were necessary, the last amplifying stage comprising five banks of 32 valves each. The total H.T. consumption amounted to 6,000 milliamperes at 350 volts. On the L.T. side 350 amperes were taken at 6 volts. Energy was provided by a motor generator giving 350 volts and Exide accumulators aggregating 2,000 volts, the total weight of the power plant being nearly four tons. Twelve miles of heavy armoured cable were buried, and the task of preparing the complete installation occupied a large staff for more than a fortnight.



A corner of the Marconiphone control room, showing the power banks. Eight LS5A valves were used in each, the total number of amplifying valves amounting to 150.

The loud speakers performed several useful functions besides keeping spectators informed as to the progress of events. Band music was relayed with excellent clarity, and tactful announcements were made regarding the control of traffic and the movement of the crowds.

When we recall, also, that a running commentary on the air battle was broadcast all over the country by the B.B.C., we can begin to assess how much would have been lost if wireless and valve amplification equipment had not been available.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

5SW AND EMPIRE BROADCASTING.

Sir,—Through your Correspondence columns I should like to make a few remarks about 5SW. Letters are continually being published, from various parts of the Empire; but I have not yet seen a Rhodesian burst into print on this much discussed subject.

Officially, that is, as far as P.M.G. licences are concerned, there are only about fifty licensees in S. Rhodesia, including nineteen transmitters.

A transmitting permit costs 20s.—power allowed being 50 watts. I doubt, incidentally, if there is any country in the world where a better feeling exists between the P.O. and the amateur transmitter—or where the Post Office has shown greater consideration in technical matters.

I think that all of us here have the same grievance against the B.B.C as the rest of the Empire has.

The point is: Why is the evening "News Bulletin" still not allowed to be broadcast from 5SW?

Why has the Empire, those who live in far away and lonely places, to be denied an interesting fifteen minutes of Home News every night?

In any case, if the news is not broadcast, what about some music from 5SW?

Must we endure fifteen minutes of an unpleasant generator hum; nothing else being permitted to modulate 5SW's carrier.

Many of us would very much like to know *why exactly*, since 5SW is supposed to cater for the Empire and be used for a certain amount of Empire propaganda, the most important part of the programme is considerately omitted? This has gone on for two years now.

Someone may wish to hear London—he does so, and says "I should particularly like to hear the news, when it is broadcast"; one shrugs one's shoulders apologetically, and tells the listener that the "great powers that be" don't allow such a thing.

To turn to another point, we must give 5SW the praise due for at least being our star short-wave station, as far as Rhodesia is concerned.

None of the others is in any way as good—conditions here, throughout the whole year, are rather terrible. High speed fading on most short-wave transmissions makes them sound as if they were being put through a "washing mangle."

Rhodesian time being one hour ahead of B.S.T., 5SW comes on the air at 8 p.m. (S.A.S.T.)—remaining good till about 9.30 p.m. (S.A.S.T.), when it begins to fade too badly for further reception. At odd times one can listen for an hour longer, but generally the transmission goes to pieces. As a final remark one asks if Overseas listeners are not literally bored to tears by the dreadfully dry talks from 2LO, from 7 p.m. to approximately 7.40 p.m.

Who wants to hear an Italian lesson, for example, either in England or abroad? About 1 per cent., we imagine, of all listeners. One wants amusing, not educating, or boring.

With reference to 5SW being off the air on Saturday and Sunday nights, one can merely sigh resignedly.

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Just the two nights when hard-working people get a chance to listen!

The powers who arrange the transmissions were obviously "born tired."

G. G. LIVESEY (FO3SRB), late of 2BZ and G6LI.

South Rhodesia.

VALVE OUTPUT.

Sir,—The letter from "Keentono" indicates that he is not clear as to the use of the formula described in my previous letter on the above subject, when the output valves are arranged in push-pull.

To calculate the maximum undistorted power obtainable from an output stage consisting of more than one valve, it is simply necessary to calculate the power obtainable from one valve and multiply the result by the number of valves used The reason for this becomes obvious from the following considerations.

Assuming the correctness of the operating figures given for a PX.650 valve in "Keentono's" letter, the output from one such valve will be :—

$$\frac{40^2 \times 3.5^2}{8 \times 1750} = 1.4 \text{ watts.}$$

When two valves are connected in parallel, the resulting impedance is half that of one valve, so the output becomes :—

$$\frac{40^2 \times 3.5^2}{8 \times \left(\frac{1750}{2}\right)} = 2.8 \text{ watts.}$$

With the push-pull arrangement, the impedances of the two valves are in series, so the impedance of the combination is twice that of one valve. The signals impressed on the grids of the two valves are 180° out of phase, from which it follows that the maximum A.C. voltage that can be applied between the two grids is twice that which can be applied to one valve. Before substituting in the formula for grid bias, therefore, this valve must be doubled.

Applying these considerations to the figures given, the output from two PX.650 valves in push-pull will be :—

$$\frac{(2 \times 40)^2 \times 3.5^2}{8 \times (1750 \times 2)} = 2.8 \text{ watts.}$$

From the above remarks it can be seen that the generalised formula becomes :—

$$W = \frac{(PG)^2 \times A^2}{8 \times \frac{PI}{N \div P}}$$

where W = Maximum watts undistorted power from output stage.
G = Grid Bias for each valve.
A = Amplification factor.
I = Impedance of each valve.
N = Total number of valves in stage.
P = 2 for push-pull arrangement or 1 for the single sided arrangement.

By cancelling, however, P disappears from this formula, which then becomes :—

$$W = \frac{G^2 \times A^2}{8 \times I} \times N.$$

It must be emphasised that G only equals grid bias when a valve is used for which grid current commences to flow at zero volts on the grid. If, as in the case of some indirectly heated valves, grid current commences at a negative grid potential, this potential should be subtracted from the grid bias to obtain the G for the formula.

ED. A. H. BOWSHER.

Ilford, Essex.

AMATEUR STATUS.

Sir,—With reference to the letters published regarding the status of amateurs, may I say how sorry I am to see that you are again raising the question of amateur transmitters?

May I enquire what good these amateurs do?

One or two of them, I agree, are worth their salt, but the vast majority merely transmit for amusement, talk the most utter rot over the ether, and have no idea of experimenting, and could not if they tried.

No, sir, I think the transmitting amateur is best off the air, and as far as I am concerned I am pleased to say they appear to be petering out in my district, and I do not receive their bleatings and croaks on a Sunday when tuning in the foreigners.

B. GLADSTONE.

London, W.14.

Sir,—I was extremely pleased to find you devoting two recent editorials to the cause of the amateur transmitter.

I should like to endorse most heartily the remarks of your contributor, "Interested Party"; I was particularly interested in this gentleman's suggestion that the amateur should press for the use of the 80-metre band allotted by the Washington Conference for the joint use of the amateur with mobile and point-to-point services. As one of the very few amateurs who have been allowed by the Post Office to make use of this band for experimental work in connection with the "R.S.G.B." Contact Bureau, I can say from personal experience of operating conditions in the new band that it appears to be almost neglected by non-amateur stations.

In my opinion, if the amateur were allowed to use the 80-metre band the interference caused to other services would be quite negligible. In any case, should the authorities be shy of opening the whole band for general amateur use, I can see no reasonable objection to the setting aside of a portion for the use of amateurs.

The acquisition of this band by the amateur would be more than a demonstration of interest, lack of which you lament in your editorial of July 3rd, for the value of these frequencies would undoubtedly be considerable.

I trust that your paper may be the means of bringing about some improvement in this matter, as it has so often done in the past in matters concerning the amateur transmitter.

R. A. FEREDAY.

London, E.11.

Sir,—Heartiest congratulations on your leading article in the July 3rd issue of *The Wireless World*. I endorse every word of your criticism of the Radio Society of Great Britain.

LET US SHOOT THIS WHITE ELEPHANT!

It behoves all amateurs worthy of the name to join up with you in your campaign to make them, in your own words, a "first-class national asset"—which they will never be so long as the present régime exists

HARRY E. SMITH.

Hackbridge, Surrey.

Sir,—We wish to heartily congratulate you on your leading articles in the June 19th and July 3rd issues of *The Wireless World*. We feel sure that all amateur transmitters will agree with the views expressed therein, and will feel deeply grateful to you for thus so ardently championing their cause, the more so as there is now no society in this country which is interested in obtaining extra facilities—or even consolidating those already held—for the amateurs.

To put the matter bluntly and in a nutshell, the whole trouble with the societies is that, so long as they can obtain special permits for certain members, then they are content to let the rest of the amateurs shift for themselves.

As an instance, the R.S.G.B. was satisfied in the past to be able to issue 32-metre permits to certain of its chosen members, who may have been—but in the majority of cases were not—capable of carrying out special research work. Any society with the interests of the amateurs of this country at heart would have insisted that if this "special" privilege was not to be available to every licensed transmitter, then they would have no use for it.

We are stressing this point because history is repeating itself, as we understand that permits to work in the 80-metre band are being obtained by the R.S.G.B. for certain of its members. Thus they are making no attempt to obtain the use of this band for the amateurs in general of Great Britain—who are as fully entitled to the use of this band as are the amateurs in the U.S.A.—but are content to sacrifice the interests of the many in favour of the few.

What is needed is a society which is prepared—and expects—to have to fight to secure reasonable rights for the amateur, and which to do so must have the confidence and respect of the amateurs of this country. As the officials of the R.S.G.B. have forfeited all claim to such, and as they have obviously no desire to undertake this task, we suggest that a complete reorganisation of the society is urgently required if the R.S.G.B. still wishes to claim that it represents amateur radio in this country.

"THE C.G."

Croydon.

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READERS' PROBLEMS

"THE WIRELESS WORLD" SUPPLIES A FREE SERVICE OF TECHNICAL INFORMATION

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Simplified Pick-up Connections.

With reference to the simple method of pick-up connection adopted in the McMichael "Screened Three" described in your issue of June 19th, I have been studying the circuit diagram with a view to adopting this arrangement in my own set, and find that the 0.0003 mfd. grid condenser is, in effect, connected across the pick-up. Will this have any effect on quality of reproduction? W. P. A.

It is a fact that this condenser is connected across the pick-up (through the tuning coil), but we do not think that this should cause any falling-off in performance. Tests made with two or three of the better commercial pick-ups showed that the addition of this capacity has no detrimental effect on the output.

oooo

Too Many Turns.

I have fitted capacity-controlled reaction to a det.-L.F. set in which variable magnetic coupling was originally used, but results are disappointing, and it is impossible to prevent self-oscillation—even with the control condenser set at minimum—unless the reaction coil is mounted at an inconveniently great distance from the aerial-grid winding. Can you tell me how to put matters right? I should perhaps add that ordinary plug-in coils are used. S. d'A. B.

It is almost certain that your reaction coil is excessively large, and it would be wise to try the effect of using a smaller inductance; it is a good plan to remove turns progressively until good control is obtained.

Very possibly you have made some other alteration that increases the tendency towards self-oscillation; it may be that an H.F choke has been added, and is fitted in such a way that it is coupled magnetically to the grid coil. This point should receive attention if a reduction in reaction coil turns does not effect the desired improvement.

oooo

The "Europa III."

Six-volt screen-grid valves are now available; I am thinking of obtaining one of these for my "Europa III," and realise that it will be essential to make some alteration to the aerial-grid circuit. Will you please give me a circuit diagram showing the necessary modifications? E. R. S.

It is assumed that you are at present using a 4-volt H.F. valve with 6-volt valves elsewhere in the set. When you make the change, it will no longer be possible to obtain "free" grid bias for the 6-volt S.G. valve from the drop in voltage across a filament resister in the negative lead, and consequently this scheme must be abandoned. A single dry cell will be required for bias purposes, and the connections will be as shown in Fig. 1.

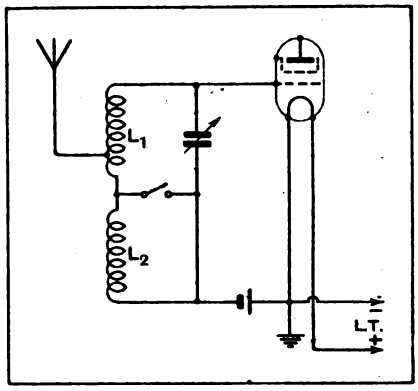

Fig. 1.—Substitution of grid cell for "free grid bias" arrangement when using a 6-volt S.G. valve in the "Europa Three."

Not Recommended.

I am thinking of building a set on the lines of the "Flat Dwellers' A.C. Three," but, with a view of reducing the number of tuning controls to one, I propose to omit the tuned grid circuit, replacing it by a simple choke coupling. Do you consider that the set modified in this way would give satisfactory results? A. C. R.

By making this alteration, the sensitivity of the receiver would be very seriously reduced, particularly on the medium waveband, and we have no hesitation in saying that in your locality—remote from broadcasting stations—you would not obtain satisfactory results from it.

There would also be a considerable falling-off in selectivity, consequent on the omission of the second tuned circuit, but probably this would not be so serious, as a frame aerial is used.

oooo

Anticipating Regional Transmissions.

Although the selectivity of my "Megavox" receiver is at present quite satisfactory, I expect that it may very possibly be inadequate in this respect when the Brookmans Park station begins operations. I believe that you have published instructions for improving the set in this respect; will you please give me a reference to the back number in which the necessary information was published? M. H. L.

A very satisfactory way of improving the selectivity of the "Megavox Three" was discussed in the "Readers' Problems" sections of this journal dated May 8th and June 5th. This involves the addition of an extra tuning condenser (for the aerial circuit), but we are afraid that there is no way in which a real and readily appreciable increase in selectivity can be made without adding to the number of controls.

oooo

Grid Leak and Tone Quality.

What should be the theoretical effect of reducing the value of a grid leak in a resistance-coupled L.F. amplifier?

I ask this question because, in my own set, the substitution of 0.5 megohm for one megohm (as specified by the designer and customarily used) does not seem to make any appreciable difference to tone, and hardly has any effect on the volume of reproduction. D. D.

The change you have made will bring about a reduced proportional amplification to the lower audible frequencies, but in all probability this change will not be appreciable by ear unless the performance of your loud speaker as a reproducer of low notes is well above the average.

If the resistance of the leak is in any way comparable with that of the anode coupling resistance, the substitution of a lower value will, as you seem to have observed, be responsible for a falling-off in overall magnification, and consequently in volume.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Lack of Selectivity.

I am troubled by the fact that the tuning of my four-valve set (H.F.-det. 2 L.F.), designed with the help of information obtained from "The Wireless World" during the last six months, is anything but selective on the lower part of the normal broadcast waveband (on wavelengths in the neighbourhood of 200 metres), although no difficulty is experienced on this score in the middle and at the upper end of the band. Is this effect normal, or does it indicate that something is wrong with my set?

A. B. P.

It is quite natural that the apparent selectivity of your tuned circuits should fall off when the condensers are near their minimum capacity settings.

Every design must be more or less in the nature of a compromise, and it is often thought best to aim at high magnification and reasonable selectivity on the wavelengths occupied (generally) by the more important transmissions, and to leave the short wavelengths to look after themselves.

We should imagine that you are using tuning condensers of about 0.0003 mfd.: if you increase this capacity to 0.0005 mfd., making a commensurate reduction in the inductance of your tuning coils, you will find that selectivity is markedly improved, and that this improvement is most noticeable at the lower end of the band.

As an alternative, and if you are particularly keen to receive these shorter wavelengths, you might make or obtain a special set of interchangeable coils having slightly lower inductances than at present in use.

o o o o

The "Europa Portable."

I am proceeding with the construction of the "Europa Portable," but am in doubt as to the precise arrangement intended for the frame aerial and reaction windings. My difficulty has arisen out of the use of a home-built wooden frame in place of the adoption of the cabinet and frame specified.

E. C. M.

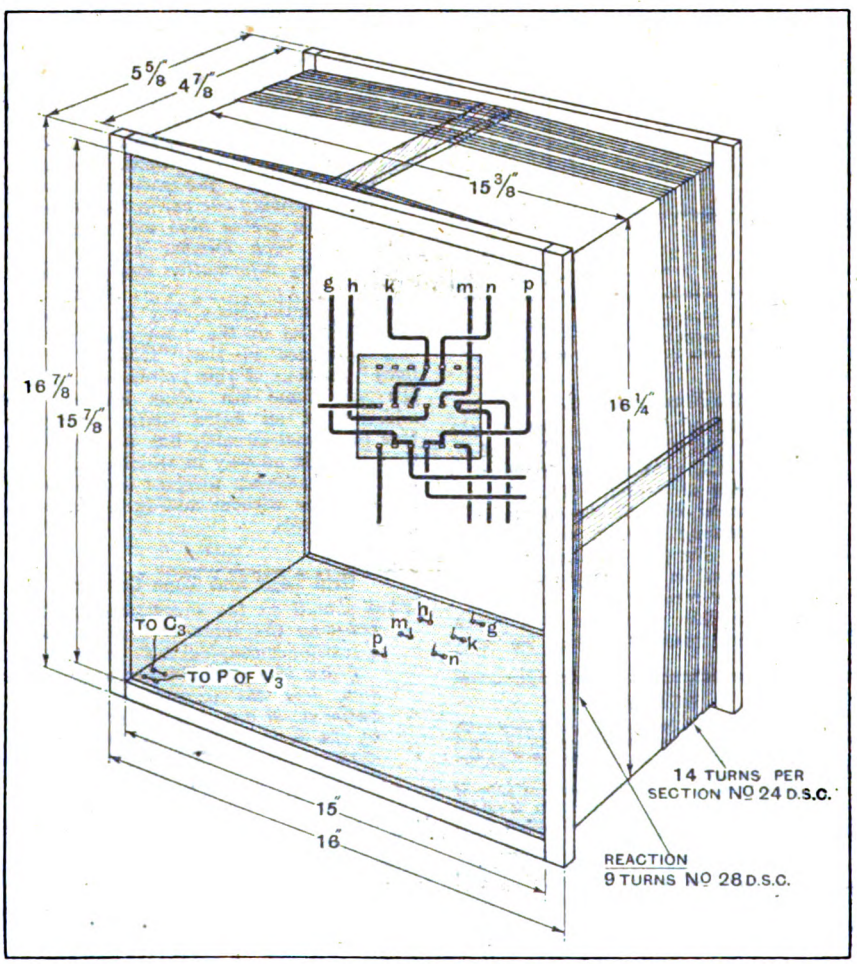

Fig. 2.—Frame aerial and reaction windings together with details of the switch connections of the "Europa Portable."

Complete details as to the method of winding the frame are given in Fig. 2. To avoid the possibility of error when making the connections between the frame and the tuning circuit, a rear view of the change-over switch has been reproduced from the practical wiring diagram and with the aid of which you will be able precisely to follow the bringing out of the frame leads. There is a space of not exceeding 3¼in. between the two windings, the turns of the reaction coil being in the same direction as those of the frame aerial.

o o o o

Frame Aerial Snags.

Would it not be possible to take advantage of the high selectivity afforded by the use of a frame aerial, and at the same time of the better sensitivity offered by an elevated conductor, by mounting a very large frame either in an attic or on the roof, running extension leads from it to the receiver on the ground floor?

L. H. R.

Apart from the more or less obvious difficulties, there are several obstacles against the adoption of this arrangement. It would clearly be a difficult matter to arrange for rotation of the frame from a distant point, and unless special precautions were taken, it would certainly be found that the receptive powers of the frame, in association with its long connecting leads, as an ordinary aerial would almost completely offset its directional properties.

The latter disability can be largely overcome, but only at the expense of considerable complication.

o o o o

Moving Coil Loud Speaker.

With a view to decreasing the consumption of current by the pot winding of my moving coil loud speaker, I propose to reduce the gap (by fitting a new centre pin) to practically half its present length, at the same time arranging for accurate centring of the moving coil former. Is this in order?

P. S. C.

From the wording of the query, we rather fancy you are under a misapprehension with regard to this matter; the effect of reducing the length of the gap will not in itself have any bearing on the current consumed by the field winding, but it will enable you to obtain an equal flux density with the expenditure of less energy for feeding this winding.

o o o o

Most Sensitive Anode Bend Detector.

Will you please tell me the best type of valve to use as an anode bend detector, when the object is to obtain loud signals on weak inputs? I take it that the special high efficiency valves now on the market, which are generally recommended for this function, are not of necessity the most sensitive to small inputs.

C. W. M.

Your assumption is correct, and to meet your needs an efficient "R.C." type of valve, with a high value of anode resistance and the largest anode by-pass condenser that can be tolerated from the point of view of high note loss, is probably the best. But the fact must not be overlooked that the newer valves have important advantages when good quality reproduction, reasonable sensitivity, and the ability to handle large inputs are needed.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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THE B.B.C. AND RESEARCH.

AT a time when so many engineers of the B.B.C. are resigning their appointments for reasons which seem to centre round the main consideration of absence of prospects and consequent small remuneration, the question once more arises as to whether the B.B.C. is justified in retaining a staff of engineers carrying out research work of a kind which directly overlaps the work of commercial companies and Government Departments.

We will admit at once that there are certain peculiar problems of broadcasting in regard to which it may be desirable that the B.B.C. should carry on its own investigations, but we cannot believe that it is more economical or better for broadcasting that the B.B.C. should design or build its own transmitters when its requirements can be met by approaching commercial companies whose sole work it is to provide such apparatus of the most up-to-date and efficient kind.

It would seem to us that before any expenditure on research is authorised the B.B.C. should answer two questions. The first question would be: "Is this research necessary to further our job of supplying programmes?" The second question would be "Is there no other source from which we could obtain our requirements without ourselves undertaking the research?"

What purpose can there be in an expenditure of public money by the B.B.C. on an investigation, say, into the properties of loud speakers, or as to the best design of receiving set? The solution of these problems is not the function of the B.B.C., and is, moreover, being pursued by commercial organisations with facilities far better than the B.B.C. could hope to provide.

We are not disposed to blame the B.B.C. alone for the present state of affairs. The example has been set the B.B.C. by the Post Office and by the Services. We have always contended that there is room for complete reorganisation of our methods of dealing with the requirements of the various Government Departments utilising wireless. In our opinion research work on behalf of the Government, whether for broadcasting, for the Post Office, or for the requirements of the Services, should be conducted by one organisation, which would supply all the technical information required and undertake the design of apparatus for the needs of the various departments. There would, of course, still be work for the various departments in the way of adapting these designs or general technical information to their own peculiar requirements. The central research organisation would work in the capacity of consultants and practical designers to all departments of the Government utilising radio.

It seems difficult to believe that such an arrangement would not effect a substantial saving in expenditure and at the same time place at the disposal of all the departments of the Government a source of technical advice and direction vastly superior to anything which the funds available to individual departments could secure.

o o o o

STANDARDISATION.

UNDER correspondence in this issue a reader urges that more attention might be paid by British manufacturers to the question of standardisation of mechanical parts in wireless apparatus.

Why, we might ask by way of example, when a standard British thread is adopted by most British manufacturers of valves for the terminal for screen-grid valves, should another manufacturer whose valves, we believe, are equally British, select to adopt a Continental thread uncommon in this country?

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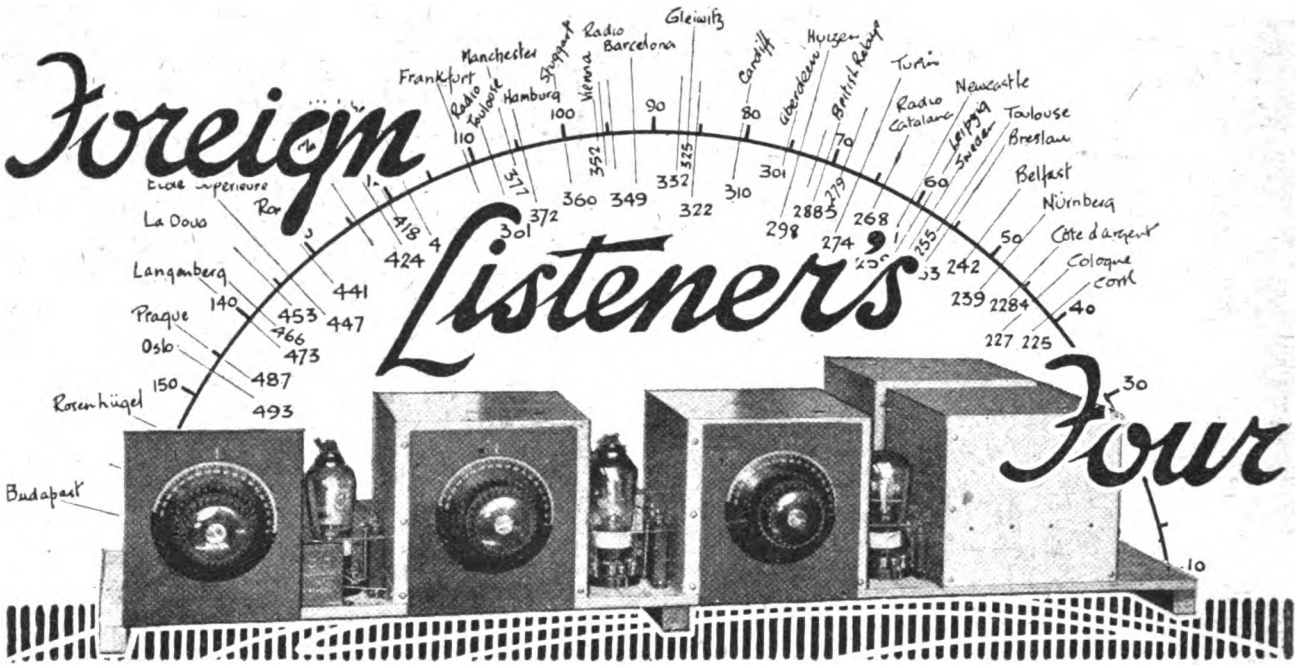
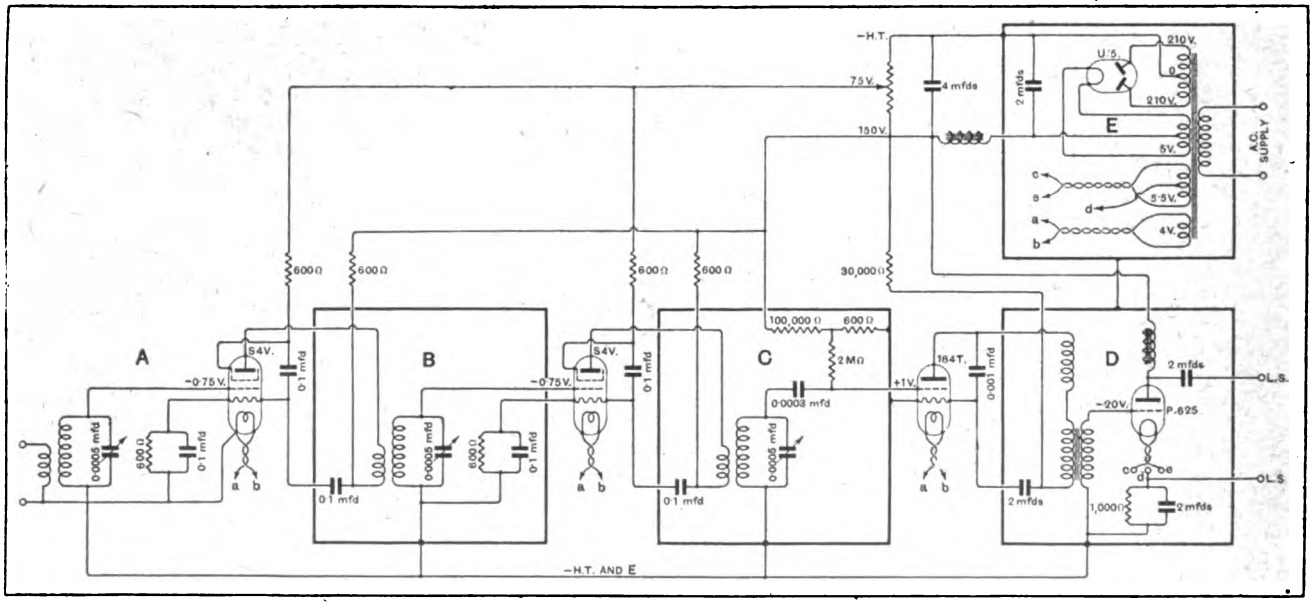


Selective Batteryless Set of the Simplest Design giving Loud Speaker Reception.

By F. H. HAYNES.

BRITISH listeners do not pay much heed to foreign programmes. Particularly is this statement true at this time of the year when the long hours of daylight limit the range of reception and atmospheric interference is prevalent. Details of foreign transmissions are rarely used for selecting programmes, but serve as a means of identifying stations which may come in uninvited in the course of swinging the dials. How many listeners are there possessing sets which will give a satisfactory rendering of, say, the programmes of Vienna, which uses 20 kW., or whose knowledge of foreign transmissions is such that they know the relative tuning positions of even the more powerful stations?

Much of the foreign reception tolerated to-day is



A.C. mains operated four-valve receiver incorporating two staple screen-grid H.F. stages. Negative bias is produced by the voltage drop across resistances. This diagram is arranged to provide short and direct leads, and the actual components in the set take up corresponding positions to the symbols in the circuit. H.F. valves are separated from their associated apparatus by the screens, while eddy current coupling is avoided by using spaced light metal boxes.

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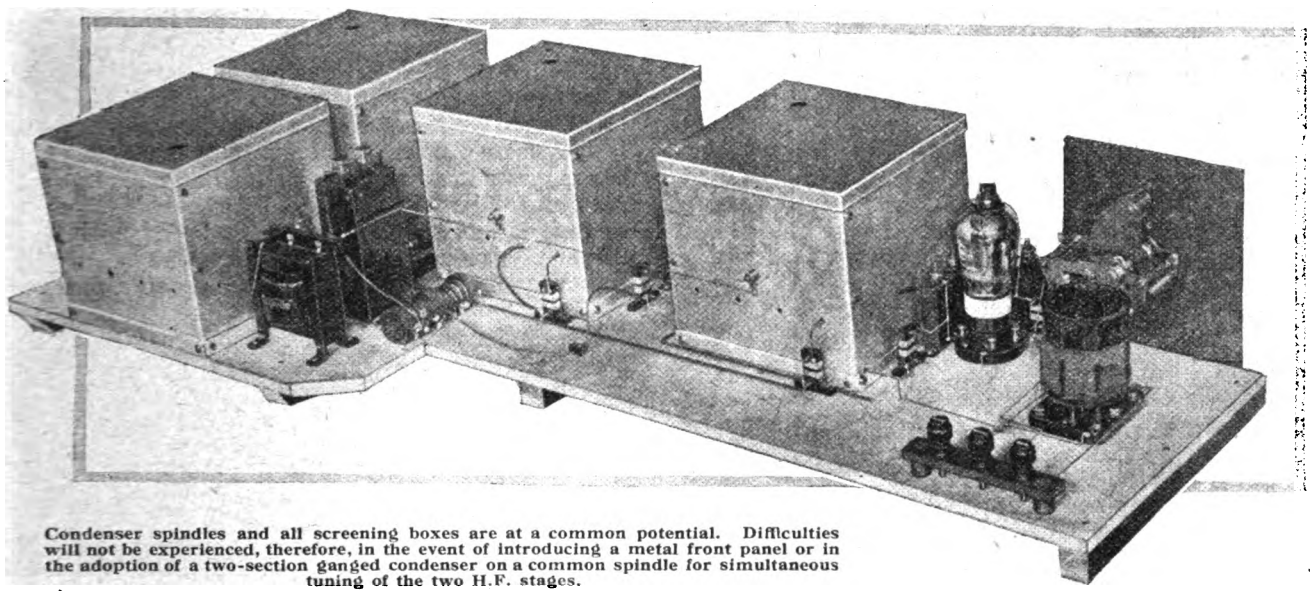
Foreign Listener's Four.—

achieved by the judicious combination of H.F. amplification and reaction, though there are many amateurs, and chiefly are they to be found among the readers of this journal, who have learned by experience that a non-oscillating H.F. amplifier makes the best long-range receiver. For some three years " range without reaction " has been the guiding slogan whenever possible behind *The Wireless World* designs. Reaction destroys quality, assuming that the loud speaker is in itself good enough to reveal faithfully the distortion which reaction introduces. Reaction produces instability and, while it undoubtedly gives enormous amplification, is of little help in eliminating interference, as is so often hoped. On the other hand, a set having a leaky grid detector may appear to gain in its selectivity by the application of reaction, as revealed by the need for critical dial settings, yet interference will still persist. Results with a receiver dependent upon reaction are inconsistent and no guarantee of performance can be given for such a set.



Condenser spindles and all screening boxes are at a common potential. Difficulties will not be experienced, therefore, in the event of introducing a metal front panel or in the adoption of a two-section ganged condenser on a common spindle for simultaneous tuning of the two H.F. stages.

It is not because we do not want foreign programmes that we content ourselves with those sent out by an organisation which prides itself upon its own good fortune in being independent of box office receipts. The receiver to be described will release us from the transmissions of the dominant local station, and will bring in distant transmissions with such constancy and absence of interference that they retain their programme value.

To achieve sensitiveness combined with selectivity without self-oscillation demands an efficient H.F. amplifier. That a satisfactory amount of amplification for foreign station reception can be obtained with a single stage set is admitted, yet the resulting degree of selectivity is far too poor for our purpose. While the prospect of the coming Brookman's Park transmissions will compel London listeners to add selectivity devices to their sets in the form of wave traps, filters, and loose-coupled aerial circuits, it is wiser, perhaps, when building a new receiver, to associate the extra tuning dial thus required with an additional H.F. amplifying stage. By this means stage amplification can be kept within the limits of easy construction and freedom from self-oscillation, while the apparent sharpness of tuning as revealed when operating the dials is similar for each of the three scales.

Stable and Selective.

This receiver is designed for operation from A.C. mains and employs valves with which it is an easy matter to obtain a stage amplification of at least 40 times combined with the use of a stable and selective intervalve coupling. The valve used in the H.F. stages —the S4V—possesses a sufficiently low value of grid to anode capacity to avoid self-oscillation even when using an H.F. transformer ratio that will produce generous amplification. Assuming that stability is produced with a primary to secondary turns ratio of 3 : 4, we are forced considerably to reduce such a primary winding so that the ratio becomes practically 1 : 4 in order that a high degree of selectivity will result. This means a cutting down of amplification, yet owing to the remarkable performance of the indirectly heated screen-grid valve mentioned and the fact that two stages are employed, this receiver possesses extraordinary station-getting properties. In addition the transformer ratio has been so modified that no longer is the grid anode capacity of the valves appreciably assisting amplification by providing reaction. Consequently, amplification is not materially modified by the change of capacity to inductance ratio of the tuned circuits in the course of moving from zero to 180 on the dials.

Pursuing this argument, one might consider the use of still another H.F. stage in the hope that the three-valve amplifier will give the desired high selectivity. If yet another tuning dial is to be tolerated for this purpose it would be wiser to introduce an auxiliary tuned circuit in place of the additional H.F. stage. Such a

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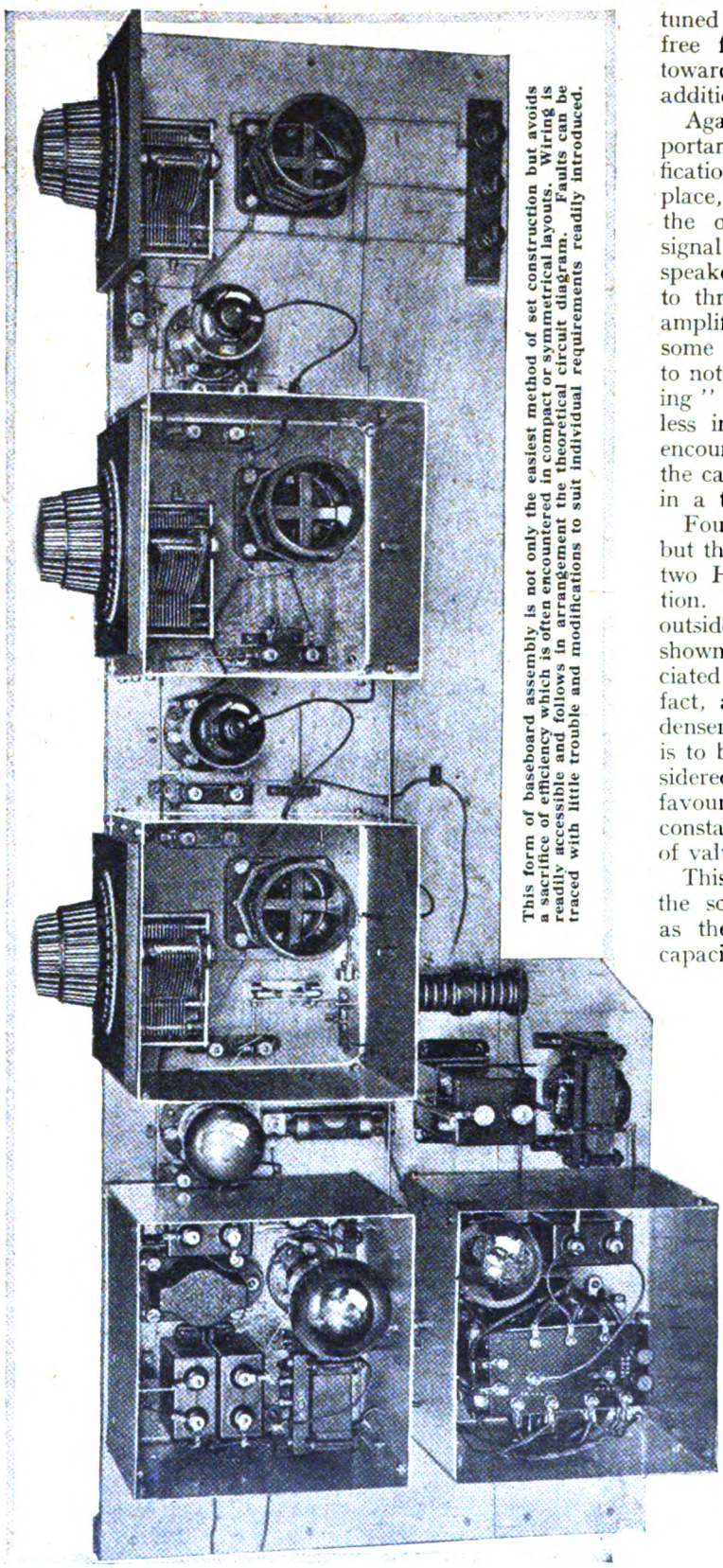

This form of baseboard assembly is not only the easiest method of set construction but avoids a sacrifice of efficiency which is often encountered in compact or symmetrical layouts. Wiring is readily accessible and follows in arrangement the theoretical circuit diagram. Faults can be traced with little trouble and modifications to suit individual requirements readily introduced.

tuned circuit unassociated with the valve and being free from valve loading would go much farther towards securing super-selectivity than would the addition of another H.F. stage.

Against the use of three H.F. valves is the important fact that the high degree of overall amplification introduces serious difficulties. In the first place, a frame would undoubtedly be substituted for the outside aerial, thus cutting down the initial signal voltage. Moreover, reaction between loud speaker leads and aerials would now be sufficient to throw the set into oscillation, while the limit of amplification at which valve noises become troublesome would have been exceeded. It is important to note that with indirectly heated valves the "rushing" noises arising out of excessive amplification are less in evidence. Another cause of noise may be encountered, viz., the A.C. of the heater modulating the carrier, although this is less likely to be met with in a two-stage amplifier.

Four dials would render tuning somewhat tricky, but the ganging of the unloaded tuned filter with the two H.F. stages is a thoroughly practical proposition. The intention with this receiver is that an outside aerial shall be used, and experience has shown us that the selectivity often thought to be associated with the frame is not always in evidence. In fact, a loose-coupled aerial tuned by a single condenser gives a generous input to the amplifier and is to be preferred to a frame. When ganging is considered, further support is given to the arguments in favour of a reduction in the primary windings if the constancy of tuning is to be maintained with a change of valve.

This arises from the considerable magnitude of the screen to anode capacity of a valve as well as the capacity between screen and grid. These capacities, which vary with different valves, are virtually connected across the primary winding and in the case of a 1 : 1 transformer are, in effect, added to the capacity of the tuning condenser across the secondary. A transformer of 1 : 4 transfers only $\frac{1}{16}$th part of this capacity across to the tuning condenser, so that the effect of a small difference in the screen to anode capacity will now vary the tuning positions only very slightly.

Reasons for Transformer Coupling.

The essential reason for using H.F. transformers as against tuned anodes tapped down to the required degree of selectivity is that the low capacity between the primary and secondary windings of the transformer, as compared with that of the coupling condenser in the tuned anode, avoids L.F. feedback and simplifies the precautions necessary to avoid L.F. oscillation. Some favour the choke-feed H.F. circuit owing to the convenience of wave-range switching which it affords. In this arrangement the merits of an efficient tuned circuit may be completely

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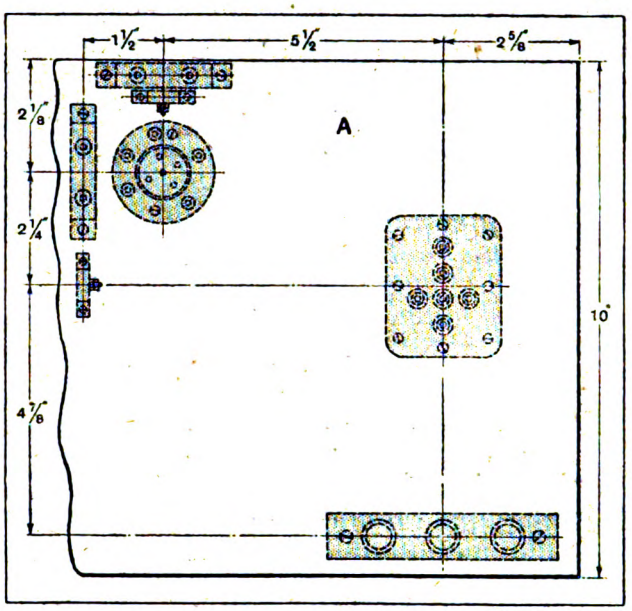
thrown away by the use of a doubtful H.F. choke with which it is in parallel. Interchangeable transformers give the two wave-ranges, an arrangement adopted owing to its simplicity. To use fixed coils giving reception on the broadcast band only is a wise modification making for simplified construction.

Grid Bias for Indirectly Heated Valves.

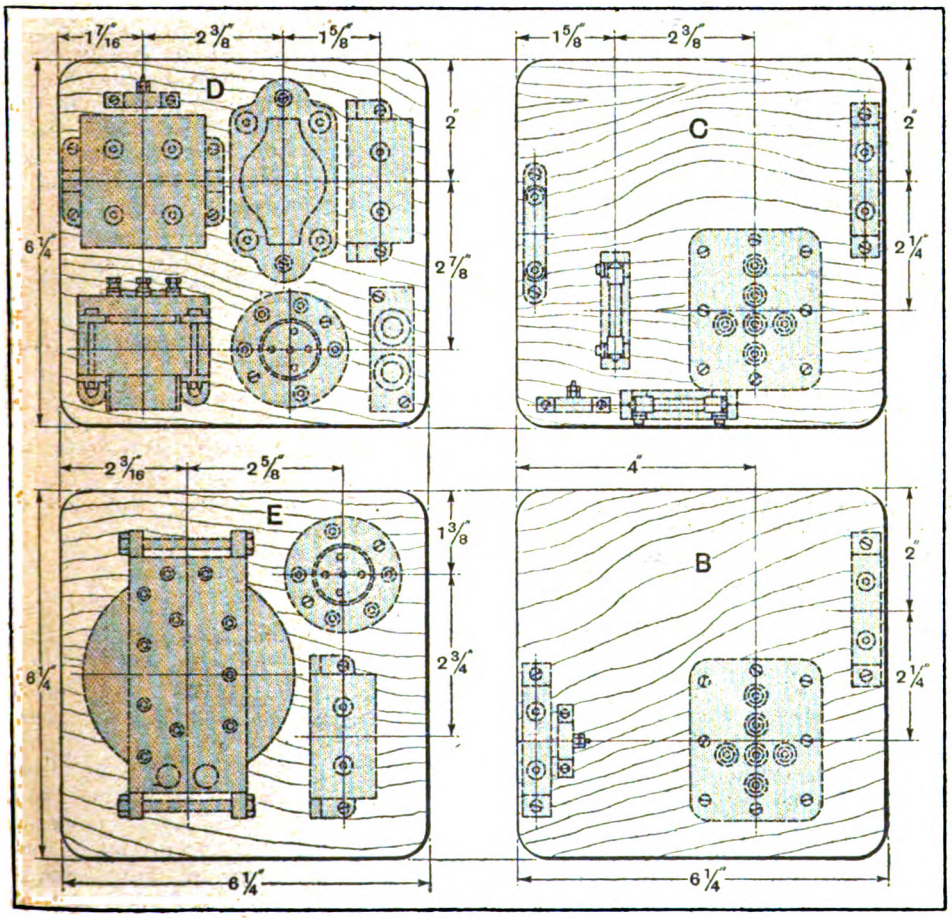
Reference to the circuit diagram will reveal the entire absence of grid cells and the substitution of the voltage dropping method of biasing. This is a new feature which has been brought about by the advent of indirectly heated valves, and would only be possible with battery operated valves, assuming the use of a separately insulated accumulator for each stage. It is worthy of note here that the dangerous back couplings through the L.T. accumulator which are so difficult to avoid with battery operated valves are not entirely removed. A negative bias of 0.75 volt is produced at the grids of the H.F. valves by interposing the 600 ohm resistances in the return path of the H.T. negative lead to the cathode.

Feed resistances in screen and anode circuits in association with condensers localise the H.F. currents to their respective stages. In this connection one should note the distribution of apparatus both inside and outside the screened units by which means stray couplings are avoided.



Plan showing the dimensional layout of the components forming the tuned aerial circuit.

Coming now to the detector, there may be doubt as to the wisdom of using a leaky grid arrangement following so generous an amplifier. The reasons for so doing are that the leaky grid is infinitely more sensitive to small inputs than anode bend, and with these small potentials there is reasonably linear relationship between input and output. Next, it is not permissible to follow an anode bend detector with transformer coupling, while to use resistance coupling with a single L.F. stage is to throw away amplification. In addition the anode load thrown back on to the tuned grid circuit is not serious in this instance, as the primary winding of the L.F. transformer is shunted by a condenser of 0.001 mfd. The presence of grid current loading is admitted, yet is not of excessive value in view of the class of tuning coil used. The generous value of the by-pass condenser permissible with the



Positions for attaching the components to the wooden baseboards which are supplied with the screening boxes.

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LIST OF PARTS.

1 Baseboard, 38 × 14in. Preferably ⅜in. or ¼in. plywood.
4 Screening boxes, 6½ × 6½ × 6in. (Bowyer-Lowe).
3 Pieces of Bakelite board or Ebonite, about 5½ × 6½ × 3/16in.
3 Variable condensers, 0.0005 mfd. (Lotus log. mid line).
5 Valve holders, 5-pin A.C. (Whiteley Boneham).
3 Slow motion dials (Ormond type R/137, order with ¼in. centre holes and ⅜in. hole in pin plate).
1 L.F. Transformer, 3 to 1 (Philips or R.I.).
1 H.F. choke (McMichael).
1 L.F. choke, 20 henrys (Magnum).
7 De-coupling resistance, 600 ohms (Groves Bros., St. Mary's Place, Shrewsbury).
1 De-coupling resistance, 1,000 ohms (Groves Bros.).
1 Resistance, 100,000 ohms (Loewe, grid leak type).
1 Grid leak, 2 megohms (Loewe).
2 Porcelain Grid leak holders (Bulgin).
1 Anode resistance, 30,000 ohms and holder (Ferranti or Varley).
1 Potential divider, 20,000 ohms (Climax).
6 Ribbed formers (Colvern new type) } Assuming that it is desired
3 Bases (Colvern, rectangular type) } to cover both wave-ranges.
4 Fixed condensers, 2 mfds. 400 volt D.C. test (T.C.C.).
1 Fixed condenser, 4 mfds. 400 volt D.C. test (T.C.C.).
6 Fixed condensers, 0.1 mfd. 400 volt D.C. test (T.C.C. type 28).
1 Fixed condenser, 0.0002 mfd. mica dielectric (T.C.C. type 34).
1 Fixed condenser, 0.001 mfd. mica dielectric (T.C.C. type 34).
1 Transformer (Radielle, type W.W.S., the Radielle Co., Ltd., 18a, Haverstock Hill, Chalk Farm, London, N.W.3).
1 Choke (Radielle type C.A.).
4 Ebonite shrouded terminals (Belling Lee).
Quantity of No. 24, 28 and 40 D.S.C. wire.
Systoflex, screws, wire, etc.

Approximate cost, £12 to £13.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed, and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

transformer is far more effective as a stopper to H.F. than would be the condenser of one-tenth of this value as used with anode bend and resistance coupling. Furthermore, there is the ruling factor that the valve itself is intended for leaky grid detection, and would give only a small output when biased back as an anode bend detector. This being a long-range set, we are legislating for potentials of less than a millivolt across the aerial coil, so that grid swings must not be estimated from the point of view of local station voltages. A positive bias of about 1 volt is desirable for the correct working of the detector valve, and is produced in this instance by a high resistance potentiometer in association with the H.T. supply. A possibility of undesirable couplings arising by this method can be dismissed in consideration of the high values of the resistances.

The output valve is a P 625, which is fully loaded, as revealed by tests with microammeter in the grid circuit and milliammeter in the plate circuit. This valve is directly heated by A.C. There is no trouble by way of ripple. The passing of 20 mA. in the anode circuit produces a bias of 20 volts by the interposing of the 1,000-ohm resistance between filament and H.T. negative. *(To be concluded.)*

Loewe Resistances and Condensers.

The vacuum type resistances and condensers made by the Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15, are now supplied fitted with screw caps. This does away with the necessity of using clips. Prices have been fixed as follows: Resistances from 10,000 ohms to 10 megohms 2s. 6d. each, condensers from 0.0002 mfds. to 0.001 mfd. 1s. 5d. each, and from 0.002 mfds. to 0.05 mfd. 1s. 8d. each. The old types are not being withdrawn and are still available.

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Change of Address.

The Mullard Wireless Service Co., Ltd., announce that the Sales and Accounts departments have been transferred from Nightingale Lane, Balham, London, to the Company's new premises at Mullard House, Charing Cross Road, London, W.C.2. The telephone number is Gerrard 0767. Owing to the expansion of their business in Birmingham, new premises have been secured at 36-37, Dale End, Birmingham. The telephone numbers are: Central 4190 and 4191. Telegrams: Mulvalve, Birmingham.

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Owing to expansion of business in the Newcastle district, the Metropolitan-Vickers Electrical Co., Ltd., have moved into larger premises at Metro-Vick House, Northumberland Road, Newcastle-on-Tyne. The telephone numbers are: Central 6202-3-4 and 5. Until the end of August, 1929, however the showrooms will remain at Saville Row, Newcastle-on-Tyne, as hitherto.

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TRADE NOTES.

Catalogues Received.

Messrs Ferranti, Ltd., Hollinwood, Lancashire. — Twenty-page illustrated book dealing with the Ferranti Multi-Range D.C. Test Set. Constructive broadsheets No. 1 and No. 2 giving details of H.T. eliminators.

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The Mainten Manufacturing Co., 126, Portland Road, Hove.—Illustrated catalogue of H.T. eliminators, loud speakers and metal cabinets.

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Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2.—Descriptive folder of the Philips Current and Polarity Indicator.

Mullard Wireless Service Co., Ltd., "Mullard House," Charing Cross Road, London, W.C.2.—Illustrated leaflet of P. M. Mansbridge condensers for radio power circuits.

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The Anelov Products, 36, Hindmans Road, East Dulwich, London, S.E.22.—Leaflet describing accumulator charging service recently inaugurated by this firm.

o o o o

Messrs. A. H. Hunt, Ltd., H.A.H. Works, Tunstall Road, Croydon.—Two eight-page catalogues dealing with electrical measuring instruments for wireless and kindred purposes.

o o o o

Messrs. Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1. — Descriptive leaflets of "Magnum" portable sets and all-electric radio-gramophone receiver.

o o o o

Radio Instruments, Ltd., 12, Hyde Street, New Oxford Street, London, W.C.1.—Descriptive folder of "Dual Astatic" H.F. choke—some interesting curves are given

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Radi-Arc Electrical Co. (1927), Ltd., Bennett Street (Dukes Avenue), Chiswick, London, W.4.—Leaflet describing the "Liberty" moving-coil loud speaker.

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The Construction and Performance of a 25ft. Logarithmic Horn.

By R. P. G. DENMAN, M.A., A.M.I.E.E.

A FEW months ago, when collecting material for a paper on Loud Speakers,[1] I obtained a long-wished-for opportunity to hear the loud speaker developed by Messrs. E. C. Wente and A. L. Thuras, of The Western Electric Company. One of these remarkable instruments, together with a 15ft. logarithmic horn, was kindly placed at my disposal by Standard Telephones and Cables, Ltd., and although I did not at that time fully realise the ability of this speaker to show up many traces of amplifier distortion which would pass unheard in a moving-coil instrument, the results created much interest. It is ill work prophesying in these matters, but after studying the work of Wente and Thuras[2] it is difficult to see how any further very marked advances can be expected to occur during the next four or five years, or until new mechanical and magnetic materials have been brought to light and their properties developed in the required specialised directions.

Readers of this journal do not need to be told that the moving-coil loud speaker can be made very good indeed, but even when the high-frequency peak in the neighbourhood of 3,000 cycles has been conquered, a few other defects remain, some of which I have not seen eliminated in any design. The " boom " tone, the small area of the source as compared with even a small group of performers, the amplitude distortion effect apparently produced by having too much speech-current in relation to the field strength, the uncertain nature of the output at very high frequencies—these are some

[1] Journal of the Royal Society of Arts, May 17th, p. 608.
[2] "Bell System Technical Journal," Jan., 1928, p. 135. See also *Wireless World*, June 6th, 1928, p. 599.

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of the blemishes to which I refer, although fully aware of the truly excellent results that can be obtained despite these difficulties.

The superiority of the large horn instrument is indeed very apparent, but, as is well known, the radiation resistance becomes uneven in the neighbourhood of the cut-off frequency, and even in the case of the 15ft. horn, with a cut-off at 60 cycles, there was some "boominess." The problem of constructing a satisfactory domestic instrument was therefore by no means easy of solution, for the folded 15ft. horn measured 3ft. 6in. in every direction, and it was desired to construct and to *conceal* a larger one still.

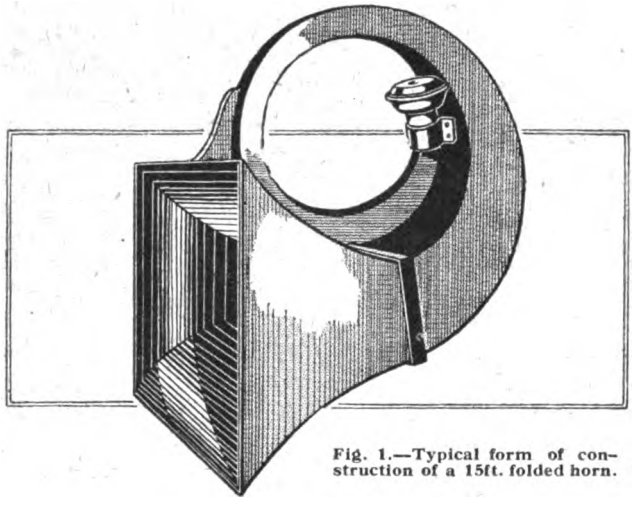

Fig. 1.—Typical form of construction of a 15ft. folded horn.

An unused chimney was examined in the hope that this might be made to house the main body of the horn, with a right-angle turn near the mouth, which was to form the fireplace. The depth, however, turned out to be insufficient. For the ultimate solution of the problem in its practical aspect I am indebted to my friend, Mr. J. R. Benson, whose scheme was as bold in conception as it has proved effective in practice. The method he suggested was to treat the entire room as the mouth of a loud speaker placed above it, and the photographs show how this has been accomplished. The room in question is octagonal, and the ceiling consists of a horizontal rectangular section in the centre, measuring 9ft. by 3ft. 6in., with the eight sides sloping down to the walls. The plan was, therefore, to build the greater part of the horn above the roof (there being fortunately nothing overhead) so that after removing the flat centre portion of the ceiling these sloping octagonal sides would form a continuation of the mouth. The final cross-sectional area was thus to be the entire area of the floor, amounting to about 400 square feet, or 40 times the mouth area of the 15ft. horn used previously.

There were one or two drawbacks to the scheme. The slope of the ceiling was rather more gentle than the theoretically correct angle of 45 degrees that the sides of a horn mouth should make with the axis, and also some reflection was bound to occur at the mouth, due to imperfect absorption within the room. But after much discussion and a careful consideration of the pros and cons, I decided to make the experiment on account of its unique character and because a complete failure seemed very improbable. At the worst, one would probably achieve results comparable with those given by the 15ft. horn; with good fortune there was a chance of securing reproduction of an even higher standard.

Before the design was drawn a preliminary experiment was made to determine the performance of the 15ft. horn at the higher audio frequencies. This horn had a continuous bend of more than 360 degrees in the same direction (see Fig. 1), and it was thought there might be a considerable amount of interference between waves traversing inner and outer paths round this bend. The performance was, therefore, compared with that of a straight 5ft. exponential horn, and it was found that the relative cut-off frequencies of the curved and straight horns under identical conditions of operation were 6,000 and 8,500 respectively. This was rather alarming, so in order to avoid any serious losses of this nature it was arbitrarily decided that the radius of curvature of the bend should never exceed five times the diameter of the equivalent circular section at any point. Moreover, the bend was restricted to a single turn of 90 degrees (Fig. 4, see title illustration).

Design Data.

There are two fundamental constants in horn design. One is the rate of taper and the other the area of the mouth opening. Corresponding to each of these constants there is a lower cut-off frequency. The mouth area cut-off (which is not sharp) may be roughly taken *as that frequency for which the wavelength equals the periphery of the mouth.* Thus the cut-off frequency of the

Fig. 2.—Metal portions of experimental 25ft. horn showing on the right the initial straight section which is 8ft. in length.

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flat rectangular portion of the ceiling is $\frac{1,100\text{ft.}}{25\text{ft.}} = 44$. If the entire area of the room could have been considered as the mouth of the horn, and the rate of taper increased accordingly, the cut-off frequency would have reached the magnificent figure of 11. But, as previously stated, the ceiling was too nearly flat to be fully efficient as a horn mouth.

It was eventually decided that the horn should be given a rate of taper for which the cut-off frequency was 32.5. This figure was arrived at as follows:—

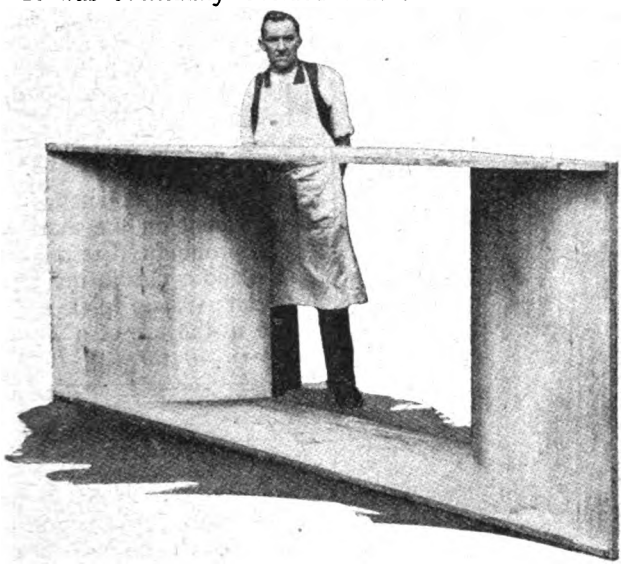

Fig. 3.—The final wood section. This is lined with sheet metal to preserve a uniform surface within the sound conduit.

(1) It gave a length (25ft.) that enabled the horn to be bent round and the throat terminated at an accessible point.

(2) While quite well suited to the 44-cycle cut-off frequency of the mouth proper, it gave the ceiling mouth-extension an opportunity to radiate still lower frequencies, if so inclined. Any peaks occurring at 30 cycles or so would be quite harmless.

Materials Used.

Having settled the rate of taper and the resulting length, the curve to be followed by the horn was drawn to scale and the proper cross-sectional areas calculated for each foot-run. The initial length of 8ft. was constructed from 20-gauge copper sheet, rolled up into a conical tube, the maximum error introduced by this departure from the true exponential shape being of the same order as the errors involved in the actual work of construction. The next section of the horn was built of "terne-plate," or lead-covered sheet-iron. It is acoustically superior to zinc and is cheaper and easier to solder. This portion of the horn weighed no less than 2½ cwt.

A change from circular to square section occupied the first eight inches of the centre section, this shape being continued round the bend until the sides of the square had been increased to 3ft. 6in. The final section was straight and was made of 1in. mahogany. Two sides of the 3ft. 6in. square forming the large end of the metal section were carried straight through the wooden portion, the other two sides being expanded more rapidly than before until the final area of 9ft. by 3ft. 6in. was attained. The appearance of the various sections at this stage of the work may be seen from the photographs (Figs. 2 and 3).

The entire 25ft. horn was now carried into the room and temporarily assembled for a trial, thick felt being wrapped round the metal portion. It was satisfactory to find at once that the precautions taken to preserve the high frequencies had been very successful. The horn showed a fine open tone and the constant tone record of frequency 8460 was reproduced as strongly as through the 5ft. straight horn. It was therefore decided to proceed with the work of erection, and the external appearance may be seen from the illustration on page 97 (Fig. 4). The input orifice is located just inside an upper room to the right of the horn. The "555W"[3] unit is screwed to the throat and is fed by two cables from the amplifier room, giving speech-current and the field current of 1.6 amperes at 7 volts (1.6 amps.).

The body of the horn is covered with four layers of pitch to a depth of about half an inch, about 1 cwt. being used for this purpose. This was found to be more than enough to extinguish the "tin bath" effect of the uncovered horn. Within the room a large grille measuring 9ft. by 3ft. 6in. is used to conceal the mouth of the horn proper. This grille only obstructs 10 per cent. of the mouth area, and is covered with white gauze. It is shown in Fig. 5. Although it is not without some slight effect in attenuating the highest tones, the impression of clarity and definition in the extreme upper frequencies is remarkable. There is some directional effect; the sound can be traced to its source and there is a concentration of the high frequencies about the acoustic axis. So far no sound-pressure measurements have been taken of this particular loud speaker, but the dotted portion of Fig. 6 is everywhere within 5 T.U. (transmission units or decibels) of two independent curves[4]

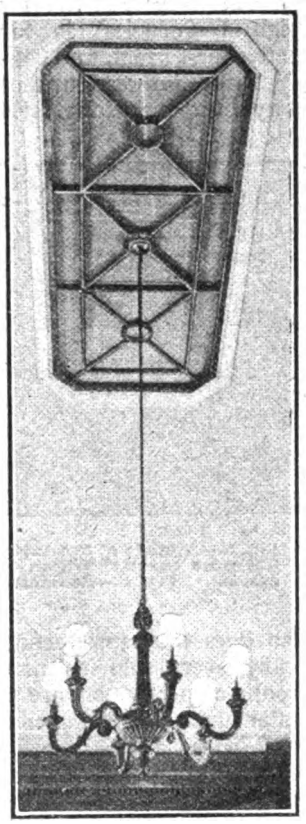

Fig. 5.—Appearance of horn mouth within the room, showing gauze-covered grille. The electric light conduit can be seen through the gauze.

[3] A product of Standard Telephones and Cables, Ltd.

[4] The curves were for horns having cut-off frequencies of 40 and 112 cycles respectively. For the latter curve see Bostwick, "Bell System Technical Journal," January, 1929, p. 148.

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of " 555W " units with large horns, and undoubtedly this curve shows the general trend of the response at a point some distance from the mouth of the horn and about 20 degrees off the axis. It will be understood that no attempt has been made to show minor resonances, which may be expected to vary widely in different cases. On the other hand, the curve corresponds very well with the results of actual experience in listening. It will be seen that the response falls noticeably in the bass but is fairly well maintained up to 6,000 or 7,000 cycles. The excellence of the high-frequency response is indeed the most striking property of this loud speaker. The tone of bowed strings (perhaps the best test for high frequencies) is far better than usual, and conveys the impression that very little is lacking. So also does the reproduction of the piano and of practically every solo instrument. Where, however, large groups of performers are present, the horn, while much better than a moving-coil cone, obviously cannot be regarded as a satisfactory substitute for the real thing, since the sound proceeds from a source of limited area. Judged aurally, the response at the lowest frequencies is just perceptibly deficient, and on the whole it is probably not worth while to construct a horn longer than 15ft. for an uncorrected " 555W " unit. The comparatively simple form of the response curve, however, suggests that the rising portion can be levelled up without much difficulty, and considerable success has been achieved in this direction. Inspection of Fig. 6 shows that the response is about 16 T.U. less at 100 than at 1,000 cycles. By shunting resistance and capacity in series across the anode resistance it is possible in effect to increase the amplification at 100 cycles relative to that at 1,000, so as to give about 4 T.U. more output at this frequency for each stage so treated. But since this method really involves suppressing the amplification in the unaffected region it means in practice that more amplifying stages are required, and in the present case only about 8 out of the lost 16 T.U. have so far been restored in this way. The result (with radio) is that one is still conscious of a certain weakness in the extreme bass. Accurate sound-pressure measurements are to be made, therefore, after which it will be possible to decide upon a suitable equalising network.

Gramophone pick-up design has been making great progress, and Fig. 7 is a response curve of a particularly ingenious pick-up due to Mr. P. Wilson. Lest it should be supposed that the curve is not very much better than those to which we are accustomed, I give also the curve of an average pick-up such as is at present on the market. The pronounced resonance at 2,200 cycles in my particular Wilson pick-up is due to the use of a Tungstyle needle, but fortunately it has been found possible to remove this by a rejector circuit consisting of a 150-turn honeycomb coil in parallel with condensers totalling 4.4 mfds. The rejector is placed in series with the secondary winding of the 25 to 1 Ferranti output transformer which feeds the loud speaker. Alternatively, fibre needles can be used, but they involve some sacrifice of high frequencies which can ill be spared.

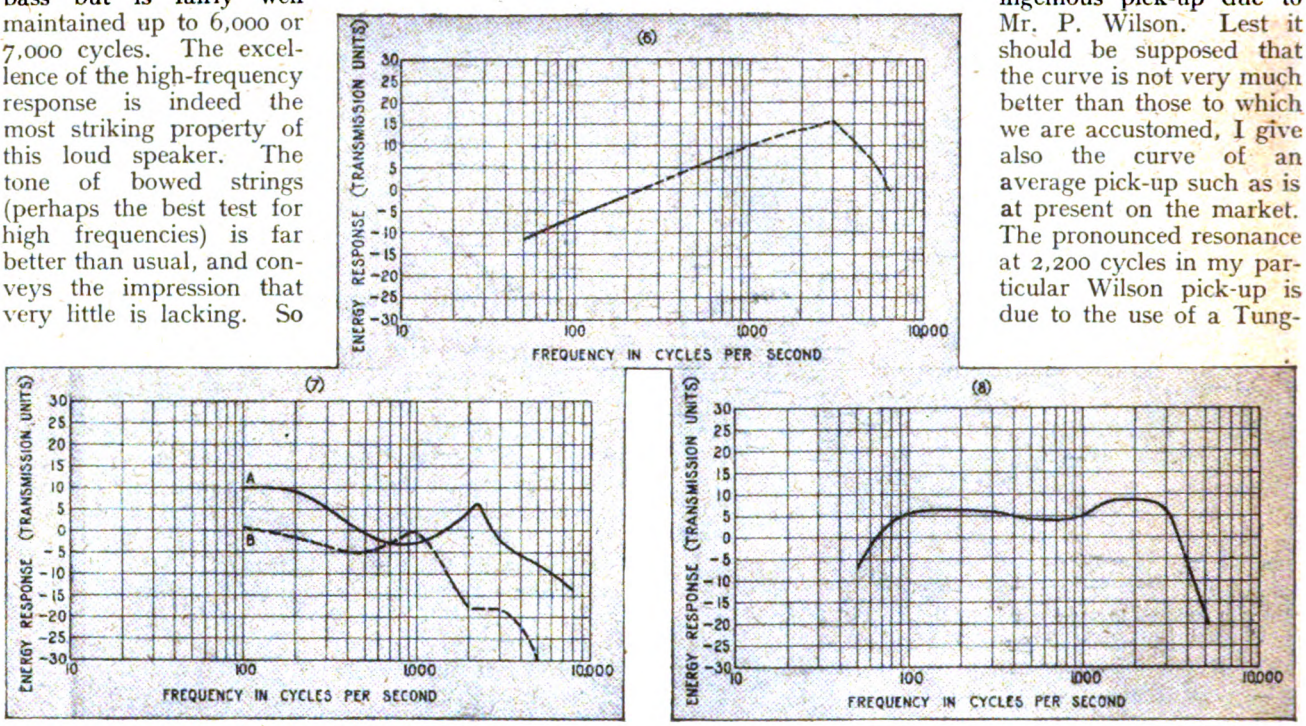

Fig. 6.—Average of two independent response curves of 555W units with large horns. Minor resonances are ignored. Fig. 7.—(A) Response curve of Wilson pick-up with "Tungstyle" needle. (B) Response curve of a typical commercial pick-up with similar needle. Fig. 8.—Estimated overall response to constant-tone records of the pick-up, amplifier and loud speaker combined, ignoring small resonances.

When the response of this pick-up to constant tone records is replotted and combined with the loud speaker response of Fig. 6 (the amplifier having been dealt with in the manner described above) the curve of Fig. 8 is obtained. The curve is within the limits of $\pm 7\frac{1}{2}$ T.U., between 40 and 4,000 cycles, and if it is only remotely accurate it is good enough to do some justice to present-day wax recording. That the overall response (whatever may be its exact shape) has been very much improved is made apparent by comparing the reproduction of an ordinary moving-coil cone loud speaker with that of the " 555W " before and after it has been matched up. In the former case it takes a few seconds to appre-

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In Search of Quality.–

ciate that the horn really is very much better; in the latter case the difference is so great that one wonders what has gone wrong with the moving-coil. In some tests with a local microphone circuit, where speech reproduction could be rapidly compared with the original voices, no differences could be detected other than those which could reasonably be attributed to the difference in the acoustic surroundings of the microphone and the loud speaker. It seems probable, therefore, that the imperfections in the loud speaker and amplifier system over the range from 60 to 6,000 cycles do not greatly exceed the tolerance of the average ear. At the same time, it is obvious, from Fig. 6, that any equalising network should be designed to reinforce the extreme upper frequencies, and here much will depend upon the conditions of listening. The response at high frequencies falls off as one recedes from the horn axis, and it has been noticed that at points some distance from the axis a setting of the amplifier that gives good balance when the room is nearly empty results in insufficient high frequencies when twenty or thirty people are present, indicating selective absorption by clothing, etc.

The choice of a suitable horn must be left to the individual, but a minimum length of about 14ft. is recommended, and if it can be made quite straight, then so much the better. A straight 27ft. horn is being installed at the Science Museum, South Kensington; it is designed to have a cut-off frequency of 32.5, but it is rather unlikely that tones of this depth will be heard from it. The intention is rather to get the best possible results out of the " 555W " speaker, so that the reproduction down to 50 or 60 cycles will be free from boominess, and also to provide a margin for any further improvements which may ultimately be made in the design of horn type instruments.

COMPULSORY WIRELESS AT SEA.

British Practice Endorsed by Other Nations.

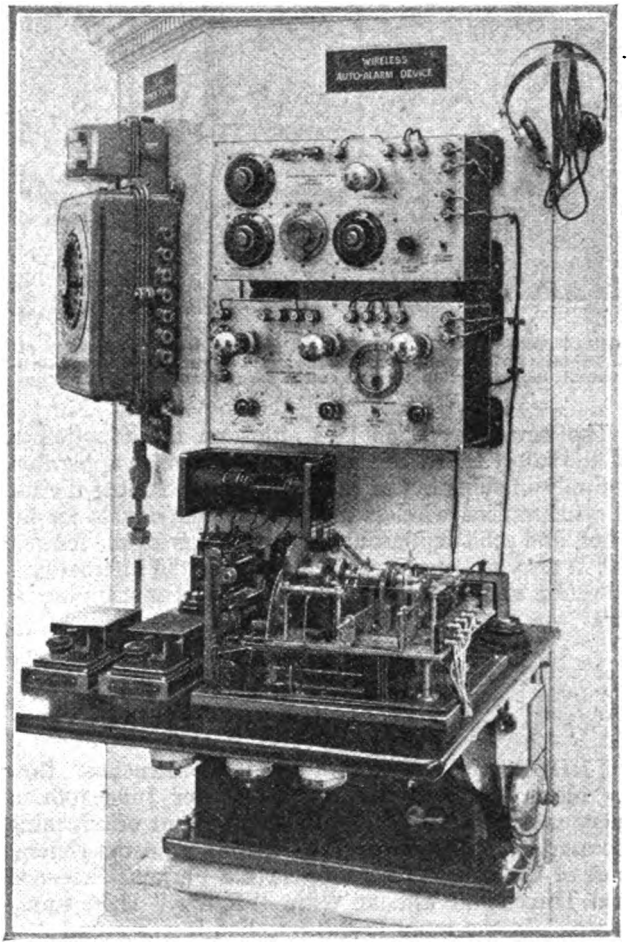
THE International Conference on the Safety of Life at Sea, which was held in London recently, has drafted a new International Convention which will, no doubt, be ratified in due course by all Governments concerned.

The last Convention, which arose out of the *Titanic* disaster, was drafted in 1914, but due to the War was never ratified. Since then, however, all countries have passed legislation in connection with the application of wireless to the safety of life at sea, and much of this legislation has been on the general lines suggested in the draft Convention. Great Britain has gone further than any other country in making regulations for the installation and use of wireless in this connection, and the new Convention will to a great extent ensure that other maritime countries come into line with the regulations already in force in this country.

In a few respects the new Convention goes further than the British regulations. At present it is not compulsory to install directional receiving apparatus in any ship, whereas the new Convention lays down that every passenger ship of 5,000 tons gross and upwards must be provided, within the next two years, with an approved direction finding apparatus or radio compass. Such apparatus enables a ship to obtain its bearing from any other ship or wireless station which is transmitting wireless signals. In the 1914 Convention there was no obligation of this sort as, at that time, direction receiving apparatus had hardly passed out of the experimental stage, and very few ships were fitted with it.

The Automatic Watcher.

Another safety arrangement that has come into prominence since the 1914 Convention was framed is the automatic alarm. This apparatus consists of a receiving



AUTO-ALARM APPARATUS of the type which has been in use on a number of British ships for nearly two years. The International Convention recommends its general use.

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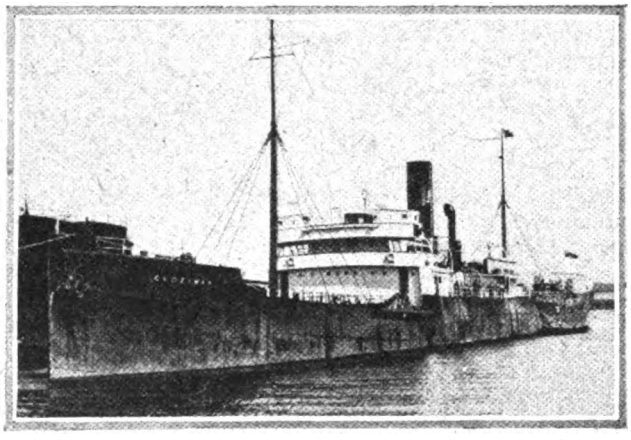
Compulsory Wireless at Sea.—

set which responds automatically to the wireless Alarm Signal which is sent by a ship immediately before she sends the Distress Signal. When this signal is received on the automatic receiving apparatus it is made to ring a bell by which means the operator can be called to the wireless cabin in time to read the message from the ship in distress. Apparatus for this purpose was designed by the wireless companies which supply ships' sets in this country, and has been in use in many British ships for nearly two years. No other countries adopted this safety arrangement, but the new Convention recognises its great importance, and differentiates the watch-keeping required in future in ships fitted with this auto-alarm from that required in ships which are not so fitted. In other words, what was a purely British wireless device for increasing the safety of life at sea has now been officially recognised as a desirable arrangement by all other maritime countries.



DIRECTION FINDING GEAR will be required on all ships of 5,000 tons gross and over within the next two years. In the picture a small loop directional aerial can be seen above the ship's bridge.

The new Convention lays stress on the adoption of all the latest forms of scientific navigational apparatus, not only in ships but at coast stations, including the use of synchronised wireless and underwater signals for the latter, and echo depth sounding apparatus for the former, and it also lays down general rules for the international collection and distribution by wireless of meteorological data

The technical regulations laid down by the Convention as regards the minimum range of ships' apparatus and the type of ships on which wireless installations must be fitted are, generally speaking, in conformity with the regulations which have been in force in this country for many years. The main installation in a ship must be able to communicate over a range of at least 100 nautical miles to another ship fitted with the simplest receiving apparatus, and emergency installations must have a range of at least 80 or 50 miles, according to the type of ship. Certain of the lifeboats, too, in large ships must be fitted with wireless telegraphy. All passenger ships must be fitted, as must all cargo ships of 1,600 tons gross and upwards, with, of course, certain specified exceptions, an arrangement which has been in force in this country for the last ten years.

Duration of Safety Watch.

In effect, the Convention stipulates that safety watch, that is to say, watch by operator, watcher, or auto-alarm, shall be continuous in all passenger ships over 3,000 tons, and all cargo ships over 5,500 tons, and that at least eight hours watch a day must be kept in cargo ships between 3,000 and 5,500 tons. The watch in other ships is left to the Governments concerned, but it is laid down that there must be at least one qualified wireless operator in every ship compulsorily fitted with wireless telegraphy. In future a watcher must be able to read code groups at a speed of 16 groups a minute and be able to distinguish the alarm, distress, safety and urgency signals. Up to the present watchers have not proved to be of much use in practice, and this higher standard of qualification will be welcomed by those who are interested in wireless safety services.

No Telephony on 600 metres.

No regulations have been laid down as regards wireless telephony except that it should not be used on waves which approximate to the distress wave of 600 metres, as it would then have the effect of rendering inoperative the automatic alarm apparatus which would naturally be adjusted for the reception of the Alarm Signal by wireless telegraphy on that wave. Wireless telephony, indeed, is practically non-existent so far as ship working is concerned, as in ships where, by regulations, a competent operator must always be carried, communication by wireless telegraphy is much more efficient than by wireless telephony.

A "TWO-H.F." FERRANTI SET.

UNDER the heading of "Kit Constructors' Problems" in *The Wireless World* for June 10th, a query was published concerning the extent of screening necessary for a two-stage H.F. amplifier on the general lines of the single stage used in the Ferranti Screened Grid Three, and with an extra "R.F.2" H.F. transformer. In the reply to this question it was stated that a certain amount of experimental work would be necessary to determine whether simple vertical screens would be adequate, and the suggestion was made that to be on the safe side, it would be wise to provide complete screening for each stage.

A letter received from Messrs. Ferranti largely confirms the advisability of taking this precaution, but it is pointed out that, if the H.F. components of the receiver are very carefully spaced, it is possible to attain complete stability with the simple vertical screens as supplied. Of course, the reaction winding of the first "R.F.2" transformer is ignored, while that on the second coupling may be connected in the normal manner.

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KIT CONSTRUCTORS' NOTES

Kit Set Circuit Diagrams—and How to Understand Them.

THANKS to the complete instructions and simplified diagrams supplied by the producers, all kit sets may be built and operated by those with no technical knowledge and something less than the average amount of manual dexterity. All may go well for a while, but sooner or later the time will come when some replacement or adjustment will be called for, and the constructor will realise the need for at least some understanding of the why and wherefore of the various components and connections. Still more will this knowledge be necessary when alterations are to be carried out; receiver design has not yet reached a state remotely approaching to finality, and, even if it had, changing methods of transmission may well render necessary some fairly extensive modification in order to provide greater selectivity than was required when the set was first built.

If the home constructor always thinks of his apparatus as a mere collection of components with lettered terminals linked together by numbered connecting wires of whose individual functions he is completely ignorant, he will always be in a weak position, and his set will be his master—a fearsome machine to be approached in fear of doing the wrong thing. On every score it pays to acquire knowledge of one's receiver; for one reason, *The Wireless World* Information Department staff (of which the writer is a member) find it impossible in all too many cases to give a definite and helpful answer to "Kit Set" problems, for the reason that the query is worded vaguely, and the fact that the answer must consequently be in general terms renders it almost valueless to the constructor who has no idea which components are associated with, say, the grid circuit of the detector valve.

Analyse the Circuit.

The ability to read theoretical circuit diagrams is a most useful foundation on which to build a deeper understanding of the working of wireless apparatus, and it is strongly urged that those who have not acquired this art should devote a few moments to the subject, checking their progress by tracing the connections of their own receivers. This article, it is hoped, will simplify the task; fortunately for our purpose, the basic circuits of all the popular three-valve H.F.-det.-L.F. kit sets are similar, and when the essentials are grasped it will be easy to understand the peculiarities of individual receivers.

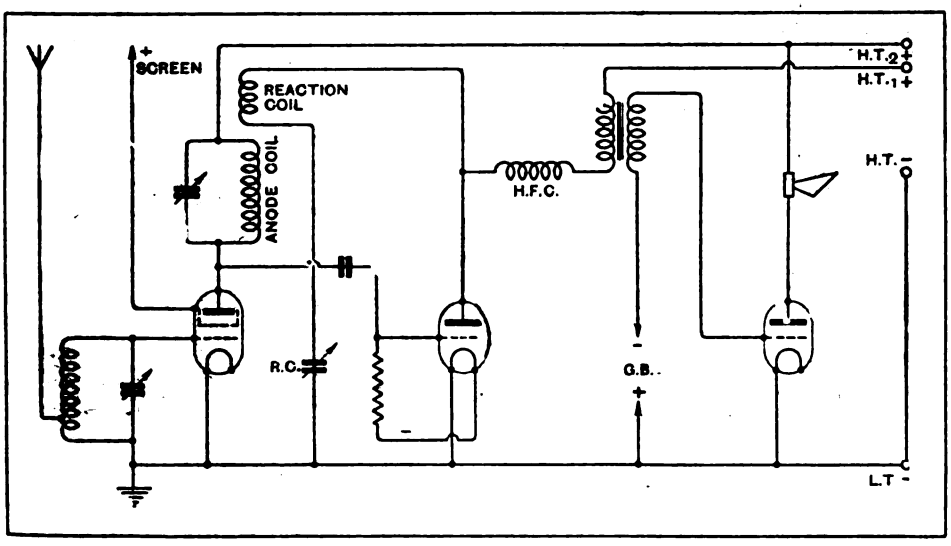

Fig. 1.—The basic circuit diagram of a typical three-valve receiver with an S.G. high-frequency valve.

Drawn in the conventional manner, the typical circuit diagram is shown in Fig. 1. It seems probable that the beginner's difficulty in mentally dividing this up into the numerous separate and simple circuits that go to make up the rather complex whole is aggravated by the fact that batteries (or other source of current supply) are common to a number of valves, and that all diagrams naturally indicate this fact. If we imagine that separate batteries are used, it becomes much easier to trace each grid and anode circuit, particularly if we always make a practice of starting at the negative filament terminal of the valve concerned. This holds good when the set is being considered "on paper." The circuit arrangement of Fig. 1, redrawn in this manner, is shown in Fig. 2, in which "starting points," common to both grid and anode, are indicated by heavy black circles, and the main circuits by thick, full lines. Subsidiary connections, not in the main grid and plate circuits, are in dotted lines, in order to avoid confusion. Incidentally, it is helpful to consider closed tuned circuits—coil and

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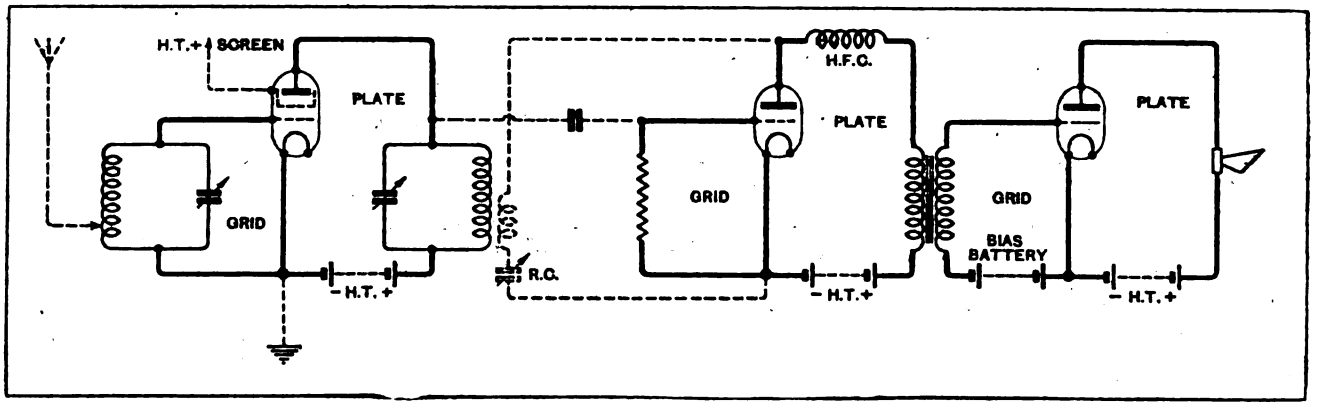

Fig. 2.—Individual grid and plate circuits of the receiver shown in Fig. 1. Filament heating connections are omitted, and subsidiary and parallel circuits are indicated by dotted lines.

condenser combinations—as a sort of resistance of a negligibly low value when out of tune with incoming signals, but of very high impedance at resonance; in the latter condition, a signal voltage will be built up across the resistance, and consequently across whatever may be in parallel with it.

Practical Details.

It is always easy to treat transformer intervalve couplings (whether H.F. or L.F.) in this way, as the primaries and secondaries are readily isolated; the first, of course, will always be in the anode circuit of one valve, and the latter in the grid circuit of its immediate successor. The majority of kit sets, however, include tuned anode H.F. couplings, and so it is simplest to regard the necessary coupling condenser (which generally fulfils the incidental and extra function of a detector condenser) as belonging to neither grid nor plate circuit, but as acting as a link between them.

Although the circuit drawn conventionally in Fig. 1, and in dissected form in Fig. 2, is typical of all 1-v-1 kit sets, it does not represent any one particular design. Taking the aerial coupling, we find that in many cases a double-wound aperiodic aerial-grid transformer, indicated in Fig. 3 (*a*), replaces the simple tapped connection. Turning to the H.F. intervalve coupling, several sets are arranged in such a way that one set of tuning condenser vanes may be "earthed" to the metal panel. This modification will be made clear by a consideration of Fig. 3 (*b*), from which it will be seen that the closed tuned circuit is completed through a large condenser in shunt with the H.T. battery.

Continuity Tests from the Grid and Anodes.

Mention has already been made of the use of H.F. transformer coupling, and of the ease with which the circuits may be dissected; this is shown in Fig. 3 (*c*). Here we may regard the grid leak as auxiliary to the main circuit, so its connections are dotted.

It will be observed that there is always a directly conductive path from grid and anode back to the negative side of the filament; it is useful to remember this when carrying out tests, but it must not be forgotten that this path will be of very high resistance in cases where a grid condenser and its associated leak are used.

Positive Bias from the L.T. Battery.

No mention has been made of filament heating arrangements. Although these circuits are essential for the functioning of a set, they are, nevertheless, subsidiary to the main grid and plate circuits, and it is safe, in the interest of simplicity, to omit them for our present purpose. It is only necessary to understand that each filament is connected across the L.T. battery, *via* a common master switch, and, occasionally, through an individual rheostat for regulation of heating current.

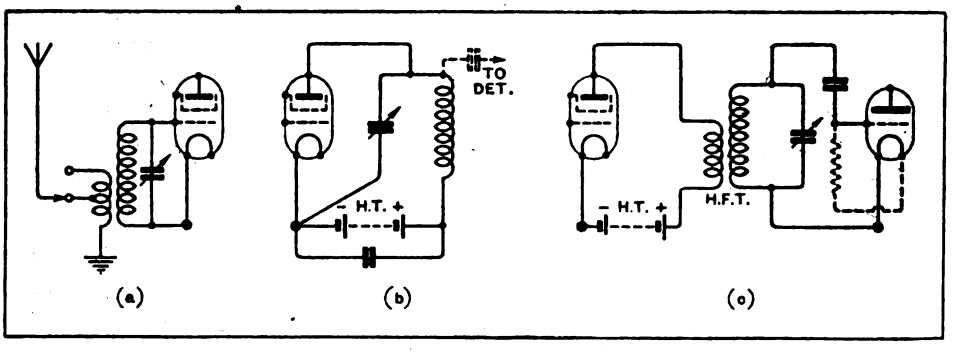

Fig. 3.—Details in which various kit sets differ from the typical example shown in preceding diagrams.

Although it has been said that grid circuts always return to negative filament, this statement should perhaps be modified by saying that in cases where leaky grid rectification is used, the leak is usually joined to L.T. positive. Our rule will still hold good, and we shall get back to our fixed starting point (negative filament) if we consider the L.T. accumulator as a bias battery which maintains the grid at a positive potential.

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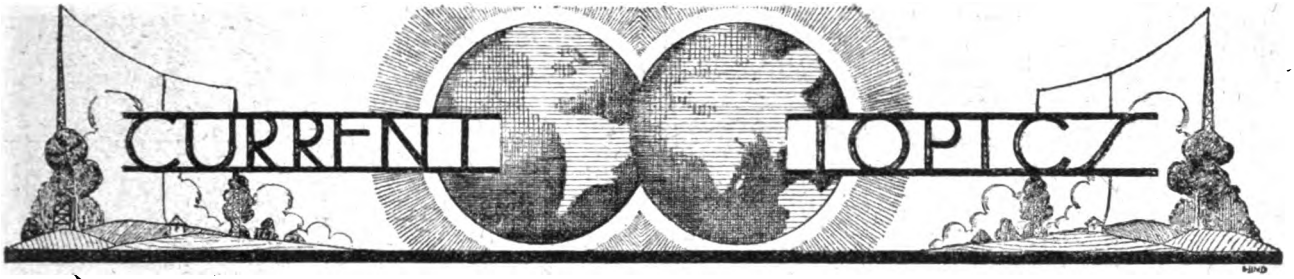

Events of the Week in Brief Review.

NEARING THE 3,000,000 MARK.

The number of receiving licences current at the end of June was 2,791,717, making an increase of 16,009 over the previous month. During the corresponding period last year the increase was 12,000.

All the monthly increases of 1929 have exceeded those of the same months of 1928.

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FRENCH BROADCASTING UNDER THE MICROSCOPE.

All aspects of French broadcasting are to be minutely examined in November next at a *Congrès national de la Radiophonie* to be held in Paris. The French Postmaster-General has accepted the post of President.

Delegates will attend to give evidence on the technical, economic, intellectual, judicial, and legal phases of the subject, and it is hoped that an entirely revitalised broadcasting system will be the result.

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A SCOTTISH WIRELESS SHOW.

An optimistic belief that the Scottish regional station of the B.B.C. will be open by the end of next year has prompted the Scottish Radio Retailers' Association to make preliminary plans for a wireless exhibition to be held in Waverley Market, Edinburgh, from November 12th to 22nd, 1930.

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AERIALS AND ÆSTHETICS.

A Berlin Court has upheld the appeal of a listener against a police order for the removal of his aerial. The police acted on the grounds that a large number of similar aerials would disfigure the city, but the Court decided, says *The Times*, that the police were justified in taking action only when a disfigurement existed, and not in the case of a mere æsthetic probability.

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WHO *DID* INVENT THE "SUPERHET"?

The German Patent Office has recognised the priority claims of M. Lucien Levy, the French radio manufacturer, for the discovery of the superheterodyne principle, writes our Paris correspondent, who states that the decision of the German authorities is contained in an official letter received by M. Levy. Three other parties put in claims of priority, viz., the Telefunken Co., of Berlin; Etablissements Ducretet, Paris; and the Société des Marques et Brevets, Paris.

The German Patent Office holds that the idea of an amplification of intermediate frequency—after the change of frequency has been effected—is clearly contained in the French patent 493,660 (M. Levy's) of August 4th, 1917, and rejects the argument that the principle was not patentable at the time the patent was taken out. The number of the German patent is 50,860, dated July 2nd, 1920.

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CLUB SECRETARIES, PLEASE NOTE!

The Radio-Club of Orly, France, makes the public announcement that one of its active members, a coal merchant, will allow discount on fuel prices to all subscribers who pay their subscriptions.

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WEATHER NEWS FROM THE ARCTIC.

According to a Moscow report, a Soviet expedition will shortly start for Franz-Josef Land, in the Arctic, to establish a meteorological and wireless station.

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ESPERANTO.

The Twenty-first Universal Esperanto Congress opens at Budapest on Friday next, August 2nd, and will continue for a week.

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HOW THE BEAM PROSPERS.

The Postmaster-General has informed Mr. Bowen, M.P., that up to March 31st, 1929, the Post Office beam services had earned gross receipts amounting to £813,100, at a cost of £538,850.

CHAMPION OF WIRELESS OPERATORS.

We regret to record the death, on Friday, July 19th, of Mr. E. R. Tuck, General Secretary of the Association of Wireless and Cable Telegraphists. Mr. Tuck, who was 56 years of age, had championed the cause of wireless operators since 1912, and was exceptionally popular with all grades in the service.

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INDEX AND BINDING CASES.

The index for Volume XXIV of *The Wireless World* is now ready, and copies are obtainable, price 3d. (post free 4d.), from the Publishers, Dorset House, Tudor Street, London, E.C.4. Binding cases for the volume can also be supplied, together with the index, price 3s. 1d., post free.

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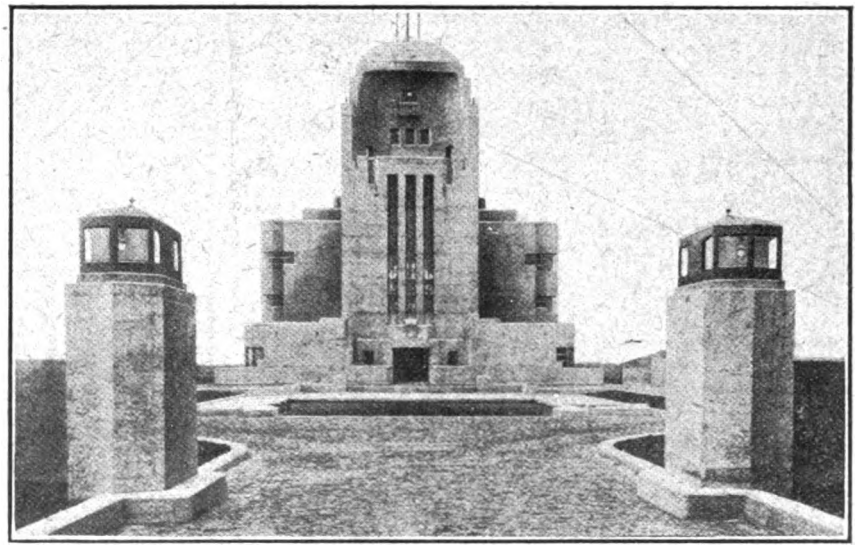
WIRELESS CHAIN FOR U.S. NEWSPAPERS.

Newspapers of the United States will shortly have the benefit of a short-wave wireless chain exclusively engaged on the distribution of news telegrams, says a Washington message. According to arrangements nearing completion by Press Wireless Inc., owners of the system, twenty short wavelengths are to be granted to them by the Federal Radio Commission for trans-oceanic communica-



RADIO AND THE MODERN ARCHITECT. A striking view of the Kootwijk (Holland) short-wave station, PCLL, used by the Government for communication with Java.

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tion, and a further twenty exclusive wavelengths at a later date for trans-American traffic.

Receiving stations will probably be erected as follows: Three in New York, one in Boston, two in Chicago, and one each in San Francisco, Los Angeles, and New Orleans.

The newspapers forming the corporation are the *Chicago Daily News*, *Chicago Tribune*, *Los Angeles Times*, *San Francisco Chronicle*, the *Christian Science Monitor*, and the Gannett publications. The organisation will have headquarters in Chicago.

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PUBLIC 'PHONES ON A LINER.

Seven short wavelengths have been granted by the U.S. Federal Radio Commission to the American Telephone and Telegraph Company for experiments towards the inauguration of a ship-to-shore wireless service on the *Leviathan* similar to those conducted recently on the *Berengaria* between that ship and Paris. Four of the allotted wavelengths will be used by the shore station at Deal Beach, New Jersey, the other three being for the use of the *Leviathan*.

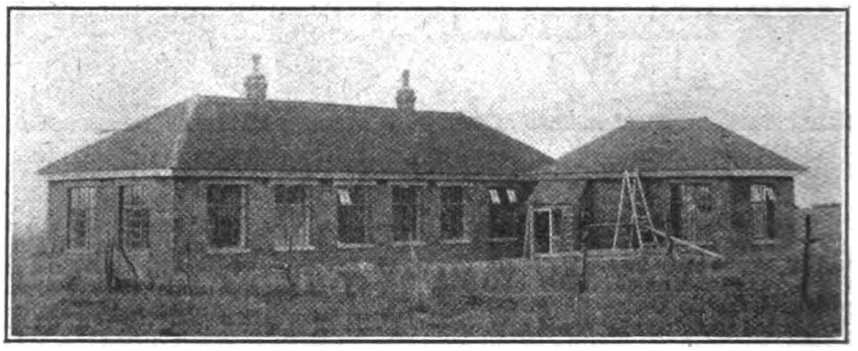
Of the 750,000 dollars to be expended on the scheme, writes a correspondent, the greater portion will be utilised in the linking up of the American domestic telephone net to the short-wave transmitter.

All staterooms on the s.s. *Leviathan* will be connected to the liner's central switchboard, and by this means will enable any passenger to receive or send a call, whether the steamer be in dock at New York, in the middle of the Atlantic, or at Southampton, some 3,600 miles away.

The tests on the *Berengaria* have proved so successful that the Cunard Steamship Company has decided to install similar equipment on the *Aquitania* and *Mauretania*.

THE TELEVISION SITUATION.

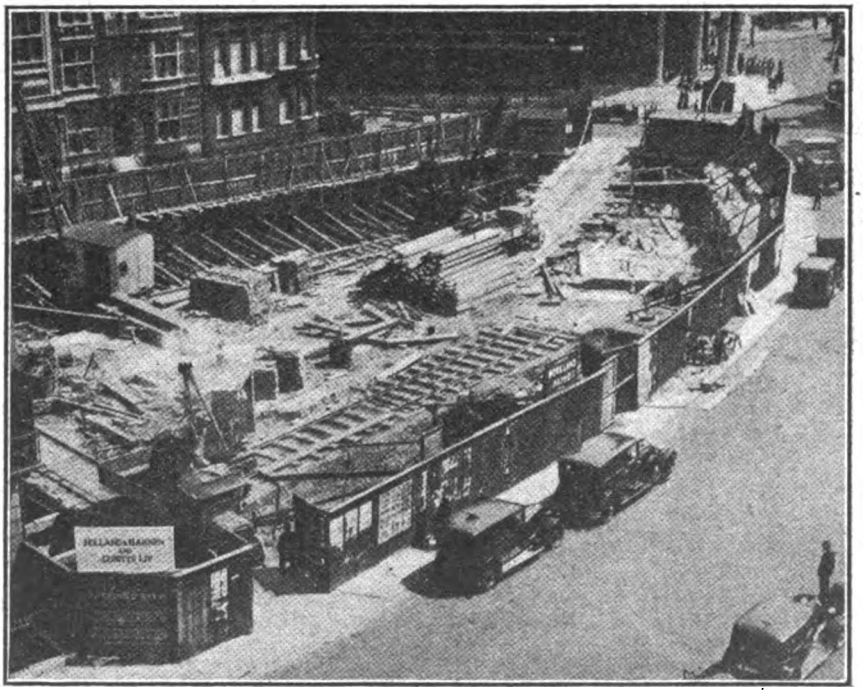
Replying to Mr. Malone and Major Church in the House of Commons last week, the Postmaster-General (Mr. Lees Smith) said that he had received representations both from the Baird Television Development Co. and from the British Broadcasting Corporation concerning the facilities offered for the use of a broadcasting station for experimental transmissions of television, but was not yet in a position to make a statement.



A B.B.C. OUTPOST. This photograph, taken last week, shows the newly completed buildings at Tatsfield, Surrey, which will house the B.B.C. receiving apparatus now in use at Keston.

MARCONI ROYALTIES ON SETS.

THE outline of a proposed agreement between Marconi's Wireless Telegraph Co., Ltd., and the Radio Manufacturers' Association in regard to royalties payable to the Marconi Company in respect of broadcast receivers sold to the public was discussed at a meeting held by the Radio Manufacturers' Association at the Hotel Cecil, London, on Wednesday last, July 24th.



FUTURE HOME OF BROADCASTING. Work has now begun on the erection of Broadcasting House, Portland Place, London, W. The photograph shows the preliminary excavations in progress. Part of the Queen's Hall can be seen in the background on the right.

The following text embodies the terms of the suggested agreement:—

(*a*) A new agreement, dating from August 28th, 1928, to August 28th, 1933, covering patented and non-patented goods for the field of broadcast reception.

(*b*) The new licence shall cover the existing patents set out in the schedule to the A2 licence, the eliminator patent (148,129, at present the subject of their D licence), all other present and future patents controlled by the Marconi Co. and their associates, the Gramophone Co., in the field, as defined in Clause (*a*).

(*c*) Licensees shall give to the Marconi Co. (and to its associate company, the H.M.V.) the free use of any patents they may possess dealing with the field as defined in Clause (*a*). In respect of the eliminator patent the actual royalty in respect of this patent shall be 5s. per apparatus when embodied in a receiving set. The charge when the apparatus is not so included shall be 6 per cent. of the retail list price.

(*d*) The Radio Manufacturers' Association will call the attention of the Marconi Co. to any cases of infringement of the patents, with a request that such infringers shall be prosecuted. Should the Marconi Company not be prepared to undertake such prosecution, the question of the prosecution shall be referred to the arbitration of the President of the Law Society, whose decision shall be binding on both sides.

(*e*) The royalty to be 5s. per valve holder, the term valve holder to have the meaning attached to it in the A2 licence.

Note.—Application for licences under this arrangement must be made to the Marconi Co. not later than August 24th, 1929.

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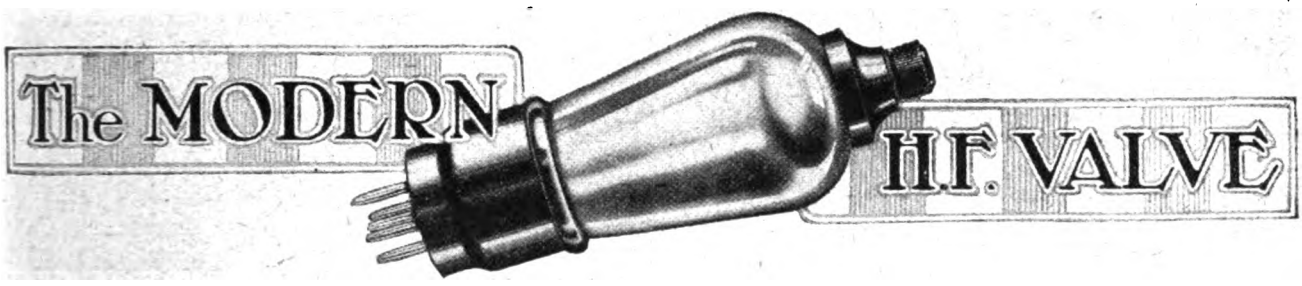
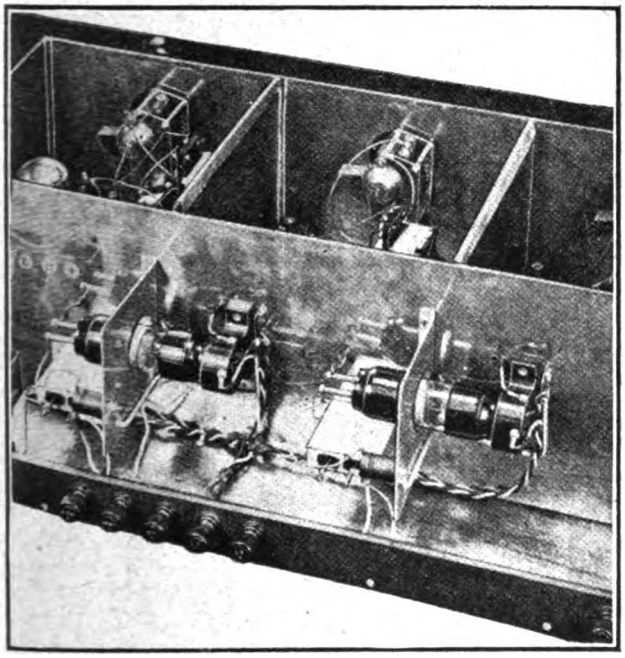


High Stage Gain and Adequate Selectivity with Screened Valves.

By W. I. G. PAGE, B.Sc.

(*Concluded from page 71 of last week's issue.*)

THE reader can now state his requirements and examine the table to see whether they can be fulfilled. For example, let us suppose that it is desired to build a receiver having a single stage of screen-grid amplification of a little over one hundred times, having a selectivity of the order of that in the "Everyman Four" type of receiver; reference to Column 10 shows that at least two of the new S.G. valves for A.C. mains will



Two-stage H.F. amplifier giving a total amplification of over a thousand. Amplification is limited by the value of the residual grid to plate capacity of the valve. (From the "Kilomag Four.")

be suitable. If lighting mains are not available, and we do not feel inclined to feed the one-ampere filament of the A.C. valve from an L.T. accumulator, we must be content with a stage amplification of about 70 or 80 and use a battery-fed screened valve (see Column 10 for valves marked S.G. in Column 3). On the other hand, it the demand for selectivity be not so exacting, the figures of Column 9 for S.G. and S.G./A.C. valves can be more nearly approached by using a two-to-one step-up transformer (see (*d*) in appendix for stage amplification), but the amplification would be likely to reach or exceed the instability figures of Column 12, and either neutralisation or a reduction in the number of primary turns might be required.

If, owing to locality, indifferent selectivity can be tolerated, screened valves can be used with neutralised transformers having an approximate ratio of one-to-one and enormous amplifications up to about 300 obtained (Column 9) when using a standard coil with a dynamic resistance of 250,000 ohms.

Practical Application.

It would now be as well to take each important column of the table and give such detail as is necessary for the amateur to work out the various factors for new valves not included.

Column 3.—It should be noted that S.G. means a battery-heated screened valve, S.G./A.C. an indirectly-heated screened valve for A.C. mains, T a battery-heated triode, T./A.C. an indirectly-heated triode, and P a pentode. The efficient H.F. characteristics of a pentode are extremely interesting in view of the large grid swing which it will handle. Second H.F. valves, where large stage gains are concerned, may require a larger signal-handling capacity than hitherto.

Column 5.—The A.C. resistance of the valves is given at zero grid volts and 100 volts H.T. It is important to note that when an H.F. valve is worked under optimum conditions of, say, minus $\frac{1}{2}$ or minus $\frac{3}{4}$ volt bias and 150 volts H.T. the working impedance is considerably lower than that given. When we come to consider that a typical modern detector valve will not accept more than, say, 20 volts total grid swing (bias $10\frac{1}{2}$ volts) it will be clear that with single H.F. stage amplifications of about 80 or 100 the grid swing on the H.F. valve must not exceed $\frac{1}{5}$ volt, otherwise detector distortion will ensue. Why, therefore, bias the screened valve to minus $1\frac{1}{2}$ volts ready to accept a signal of 3 volts? The mutual conductance, and hence signal strength, increases as the valve is worked nearer and nearer to zero grid volts, and provided the region of grid current is avoided the greatest efficiency will result from a bias of under a volt. Suggested methods of biasing 2-, 4-, and 6-volt valves are given in Fig. 2.

Column 6.—The true comparative figure of merit for

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The Modern H.F. Valve.—

H.F. valves when transformer-coupled is $\frac{\mu}{\sqrt{R_0}}$; since this generally comes to less than unity, we have multiplied by 100 in each case. Where there are H.F. performance factors of 50 and 100 respectively the H.F. output in the second case will be double that of the first. The neutralised stage gain of Column 9 will be found to be directly proportional to the column now under consideration. Stage gain where optimum transformer ratios are used is $\frac{1}{2}\mu \times \sqrt{\frac{R}{R_0}}$ from which it can be seen that the valve contributes $\frac{\mu}{\sqrt{R_0}}$ and the coil $\frac{1}{2}\sqrt{R}$. The latter can conveniently be called the "coil factor." In the case of an "Everyman Four" type of Litz coil the expression $R=\frac{L}{Cr}$ equals approximately 250,000 ohms for the medium broadcast band, therefore the coil factor is $\frac{1}{2}\sqrt{250,000}=250$. Column 9 is got by multiplying the coil factor by the valve's H.F. performance factor divided by 100. In a cheaper coil of the type just specified, but wound with the same number of turns of 22 S.W.G. solid wire (D.C.C.), R would be about 180,000 ohms and the coil factor $\frac{1}{2}\sqrt{180,000}=212$. By computing the coil factor and multiplying by one-hundredth of

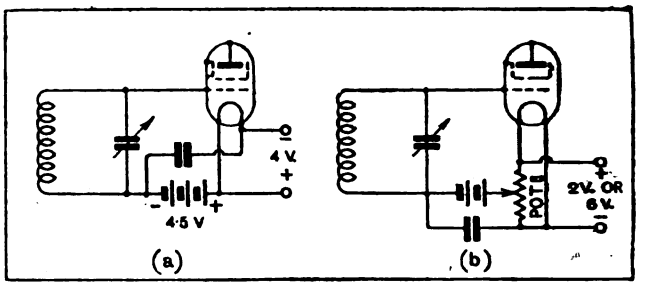

Fig. 2.—With most screened valves there is very little "straight" in the anode current-grid volts curve, and the best mutual conductance (and hence signal strength) can be obtained with less than 1½ volts negative bias. A bias of −½ volt can be obtained with 4-volt valves by connecting a 4½-volt bias battery as in (a). For 2- and 6-volt valves a potentiometer is required (b).

H.F. VALVE STATISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13
VALVE	MAKER	TYPE	AMPLIFICATION FACTOR	A.C. RESISTANCE	H.F. PERFORMANCE FACTOR	OPTIMUM TRANSFORMER RATIO	NO OF PRIMARY TURNS	MAXIMUM STAGE AMPLIFICATION NEUTRALISED	STAGE AMPLIFICATION WITH 3:1 RATIO TRANSFORMER	VALVE CAPACITY (ANODE-GRID) ($\mu\mu f$)	MAXIMUM STAGE AMPLIFICATION UNNEUTRALISED	LOWEST LOSS COIL FOR COL. 12 DYNAMIC RESISTANCE ohms
AC/S.	COSMOS	S.G./A.C.	1200	800,000	132	1	68	290	121	0·006	208	165,000
AC/G.	"	T./A.C.	36	17,500	26	3·6	16	66	—	—	—	—
SP/610G.	"	T.	19	11,000	18	4·6	14	48	—	—	—	—
220 S G.	COSSOR	S.G.	200	200,000	45	1·12	61	112	73	0·023	75	—
41.M.SG.	"	S.G./A.C.	400	200,000	89	1·12	61	224	146	—	—	—
41.M.HF.	"	T./A.C.	25	14,000	21	4·2	16	52	—	—	—	—
610 H.F.	"	T.	20	20,000	14	3·54	19	35	—	—	—	—
H.F. 610	EDISWAN	T.	25	21,000	17	3·45	20	43	—	—	—	—
S.215	MARCONI AND OSRAM	S.G.	170	200,000	38	1·12	61	95	62	0·014	81	184,000
S.625	"	S.G.	110	170,000	27	1·2	57	66	46	0·022	55	—
DEH.610	"	T.	40	60,000	16	2	34	40	—	—	—	—
HL.610	"	T.	30	30,000	17	2·9	24	43	—	—	—	—
DE5.B.	"	T.	20	30,000	12	2·9	24	29	—	(10)	3·4	—
S.G.215	MAZDA	S.G.	300	270,000	58	1	68	144	84	0·005	153	280,000
PM.16	MULLARD	S.G.	200	200,000	45	1·12	61	112	73	0·015*	88	160,000
PM.S4.V.	"	S.G./A.C.	1000	1,330,000	87	1	68	158	61	0·015*	98	—
PM.354.V.	"	T./A.C.	35	14,000	30	4·2	16	73	—	—	—	—
PM1.H.F.	"	T.	18	22,500	12	3·3	21	30	—	—	—	—
PM5.X.	"	T.	17·5	14,700	14	4·1	17	36	—	—	—	—
PM.26	"	P.	50	25,000	32	3·2	21	80	—	—	—	—
SS.215.SG.	SIX-SIXTY	S G.	190	220,000	41	1·07	64	102	64	—	—	—

* *Subject to confirmation by the valve manufacturers.*

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The Modern H.F. Valve.—

the valve's performance factor as given in Column 6, the stage amplification can be obtained for various coils.

Column 7.—The optimum transformer ratio is $\sqrt{\frac{R}{R_0}}$. Taking R, as before, to be 250,000 ohms for 68 turns of 27/42 Litz on a 3in. Paxolin former, it is clear that when R_0 is less than 250,000 ohms the expression $\sqrt{\frac{R}{R_0}}$ is greater than one and the transformer must have a step-up ratio. There are three screened valves where R_0 (Column 5) is greater than 250,000, and theoretically a step-down ratio is indicated. Were we to wind a primary of more than 68 turns, the selectivity would be extremely bad, and, owing to the fact that the screen-to-anode valve capacity of, say, 10 $\mu\mu$F. is shunted across this winding, there might be trouble due to resonance and curtailment of wave range. With the three valves concerned, therefore, a one-to-one transformer has been specified as being a compromise between tolerable selectivity and signal strength.

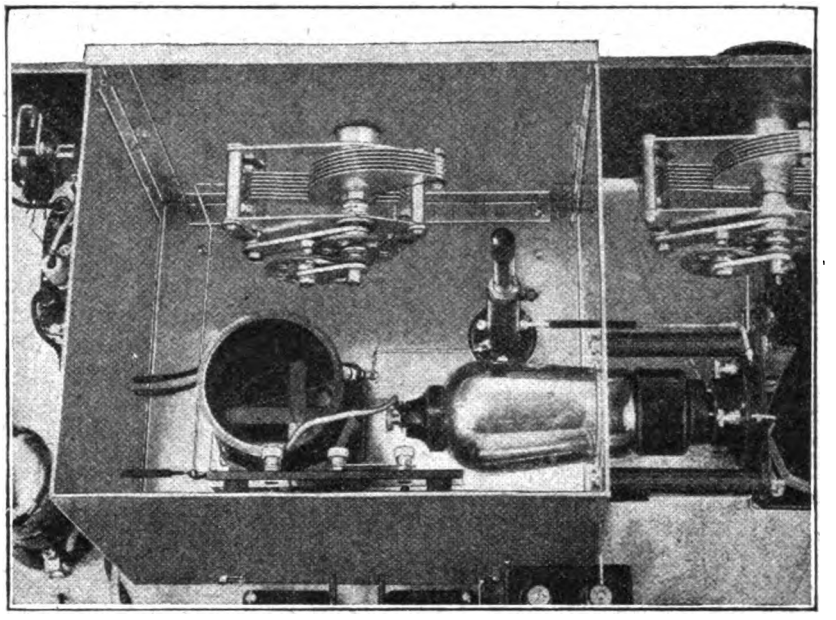
Column 8.—The number of primary turns given assumes a 68-turn secondary. To realise a coefficient of coupling of about unity the primary must be wound very close to the secondary and turn for turn with that winding. Fine wire should be used and the winding started over the low potential end of the secondary.

Column 9.—Only in one case can a modern screened valve theoretically be used with a coil where R = 250,000 ohms with stability without neutralisation. The stage amplification in this column is therefore for valves when neutralised. The figures are obtained from the expression $\frac{1}{2}\mu \times N$ where $N = \sqrt{\frac{R}{R_0}}$, except for the three screened valves already discussed, in which case the expression (*b*) in the appendix applies.

Column 10.—As explained before, these figures for a non-optimum step-up of three-to-one obtained from (*d*) in the appendix for screened valves, do not show a reduction of amplification to one-third. Compare Columns 9 and 10.

Column 12.—Calculated from expression (*c*) in the appendix. It has been considered fair to take the amplification at 200 metres, since absolute stability will exist up to 600 metres. If we made the threshold instability at 300 metres the receiver would be unstable at 200 metres, but the amplification over the stable range of 300 metres upwards would be considerably greater. The magnitude of the figures in this column depend a great deal upon the valve capacity as given in Column 11.

All the stage amplifications quoted are for the high-frequency amplifier *per se*, but no account has been taken of the anti-phase feed-back due to an anode bend detector valve. It may, no doubt, be of interest to give a numerical example. If the anode detector is followed by L.F. transformer coupling with, say, 0.0003 mfd. across the primary, the load thrown back on to the H.F. transformer is equivalent to about 10 ohms,[1] which must be added in series with the high-frequency resistance already existing in the tuned secondary circuit. In assuming that a typical "Everyman Four" type of transformer secondary has a dynamic resistance of 250,000 ohms, we have taken the high-frequency resistance at 300 metres as 10 ohms, for



By means of interchangeable coils and a change-over lever a neutralised triode may be substituted for the screen-grid valve. Stage gain and selectivity can be readily adjusted to suit requirements. (From the "Schools' Demonstrative Receiver.")

$R = \frac{L}{Cr} = \frac{250\mu H}{0.0001\ mfd.} \times 10\ ohms = 250{,}000\ ohms$. What is the effect on stage amplification of an increase from 10 to 20 ohms? Taking the case of a neutralised H.L.610 valve, the optimum transformer ratio will be reduced from approximately three-to-one to two-to-one, and the stage amplification from about 43 to 31. When the anode bend detector is followed by resistance coupling the effective load thrown back is considerably less.

Column 13.—Here the lowest loss coil is shown which will just make the unneutralised valve on the verge of oscillation at 200 metres. The figures are worked out from (*a*) in the appendix when H = 2 at 200 metres. It would seem that Litz coils (except in one case) are hardly necessary when a screened valve is not neutralised and when a tuned anode or one-to-one transformer is used.

In Conclusion.

Summarising, we can say that the new range of S.G. valves for A.C. mains, giving stage amplifications of 100 to 300, are unprecedented in their performance. The

[1] "Improving Detector Efficiency." *The Wireless World*, May 22nd, 1929, p. 524.

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The Modern H.F. Valve.—

indirectly heated triodes come very close to the battery-heated S.G. valves when the latter are used with suitable step-up transformers to give equal selectivity, but the battery-heated triodes still fall in a class wherein the maximum stage amplification is about fifty times, using standard coils and components.

APPENDIX.

The expression which gives the value of the maximum dynamic resistance (lowest loss) of coils which can be used before instability, due to anode-grid capacity, sets in for any valve is as follows (a one-to-one transformer—or tuned anode—is assumed, together with perfect external screening) :—

$$H = \frac{C_0 \omega g}{\frac{1}{R}\left(\frac{1}{R} + \frac{1}{R_0}\right)} = 2 \quad .. \quad .. \quad .. \quad (a)$$

Having obtained the value of R which makes the expression H=2 at 200 metres, the stage amplification A is obtained by the usual formula for resistance-coupling :—

$$A = \mu \frac{R}{R + R_0} \quad .. \quad .. \quad .. \quad .. \quad (b)$$

If it is required to arrive at the maximum stage amplification A in one expression without the intermediate step of finding R, the following formula is used :—

$$A = \frac{-1 \pm \sqrt{1 + 2\mu R_0 \omega C_0}}{\omega C_0 R_0} \quad .. \quad .. \quad (c)$$

In order to obtain really sharp interstage tuning with screened valves, H.F. transformers with step-up ratios of 2, 3 or 4 to 1 can be used instead of the value of approximately one-to-one (see Column 7), which gives optimum stage gain. To find the decreased stage gain resulting from any non-optimum step-up ratio the following expression is used :—

$$A = \frac{N\mu R}{R + N^2 R_0} \quad .. \quad .. \quad .. \quad .. \quad (d)$$

In all the above formulæ it is assumed that we are dealing with the medium broadcast band (200-600 metres), and that the dynamic resistance of a coil is substantially constant over this range. Furthermore, if expressions (*a*) and (*c*) are solved for threshold instability at 200 metres ($\omega = 10^6 \times 2\pi \times 1.5$) the receiver will be increasingly stable up to 600 metres.

A = stage amplification.
C_0 = anode-grid capacity in farads.
g = mutual conductance in amps/volts.
μ = amplification factor of valve.
R_0 = A.C. resistance of valve (ohms).
R = dynamic resistance in ohms.
$\omega = 2\pi \times$ frequency.
N = step-up turns ratio of H.F. transformer.

[*Erratum.*—In Part I the reference to "column 13" on page 71 should read "column 12."]

KIT CONSTRUCTORS' PROBLEMS.

Advice on the Practical Operation of Some Popular Sets.

The Information Department Service has been extended to deal with problems encountered by builders of "kit" sets discussed in these pages. Receivers already treated are the "New Cossor Melody Maker," Osram "Music Magnet," Mullard "Master Three Star," Six-Sixty "Mystery Receiver," Ferranti "Screened Grid Three," Formo "Screened Grid Three," Dubilier "Toreador Screened Grid Four," McMichael "Screened Three," and the Mullard "S.G.P. Master Three." The service is subject to the rules printed in the "Readers' Problems" section.

Semi-ganged Control.

In your published description of the "Dubilier Toreador Screen Grid Four" you make mention of the fact that the three condenser control drums are mounted side by side and that two of these controls may be actuated together over a certain band of wavelengths. The operation of the third condenser is not discussed; should it be worked simultaneously with the others? A. A. C.

Two of the variable condensers in this set are for tuning purposes, while the third is for reaction. This latter control is more or less independent of the setting of the tuning dials, and purely from the operating point of view there is no advantage in its dial being mounted adjacent to the others.

When searching for distant transmissions it is advisable to operate the two tuning controls proper with one hand (indeed, over a limited wave-band with one finger), while the reaction control is actuated by the other hand.

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Pentode and Loud Speaker.

I am taking my "Osram Music Magnet" to the west coast of Ireland, and in order to obtain the extra sensitivity which it seems will be necessary propose to replace the present triode output valve by a pentode. Do you think that my cone loud speaker will give good results with this valve, or would it be necessary to obtain a special output transformer? R. H. R.

In all probability your present loud speaker will work well with the new valve, particularly if its windings are of fairly high impedance, but, if you are not satisfied with the quality of reproduction, you should try the effect of shunting a comparatively large fixed condenser across the loud speaker terminals. We suggest a value of about 0.002 mfd.

Changing the Detector Valve.

I am building the "Home Constructor's Screened Dimic Three," and as I do not intend to use the set for gramophone reproduction should be glad to know if any increase in range could be obtained by using a detector valve of higher amplification factor than that specified. A. T. S.

Yes, this deviation from the specification is permissible, but in order to attain any sensible increase in range, combined with good quality reproduction, you will be well advised to use an L.F. coupling transformer with a high primary inductance.

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A Safety Precaution.

I have obtained some H.T. fuses and intend to add them to my Mullard "S.G.P." with the idea of protecting both valves and battery in the event of a short-circuit. Will you please tell me where the fuses should be connected? E. P.

A single fuse joined between the H.T. negative terminal and the battery itself should be sufficient for all practical purposes, but, to be absolutely safe, it would be better to connect separate fuses in each of the three positive feed leads.

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Incorrect Inductance.

My "Dimic Three" is giving good results on the long waves, but on the medium broadcast band its performance is anything but satisfactory; in fact, the left-hand tuning condenser has little effect and must be set at zero for the reception of 5GB and 2LO—the only two stations I have been able to receive. Does this symptom convey any indication to you as to what is wrong? M. R. S.

It seems almost certain that you are using the wrong type of coil in the aerial-grid circuit, and we are inclined to think that you have probably inserted in this holder a coil of the same inductance as that used in the detector grid circuit. If you consider Fig. 1 of our descriptive article, which appeared in the issue of June 19th, 1929, you will see that the variable condenser is shunted across the whole of the aerial-grid coil L, while the tuning capacity is in parallel with one half only of the corresponding detector-grid inductance L_{2a} and L_{2b}. Consequently, a smaller winding is required for the first position.

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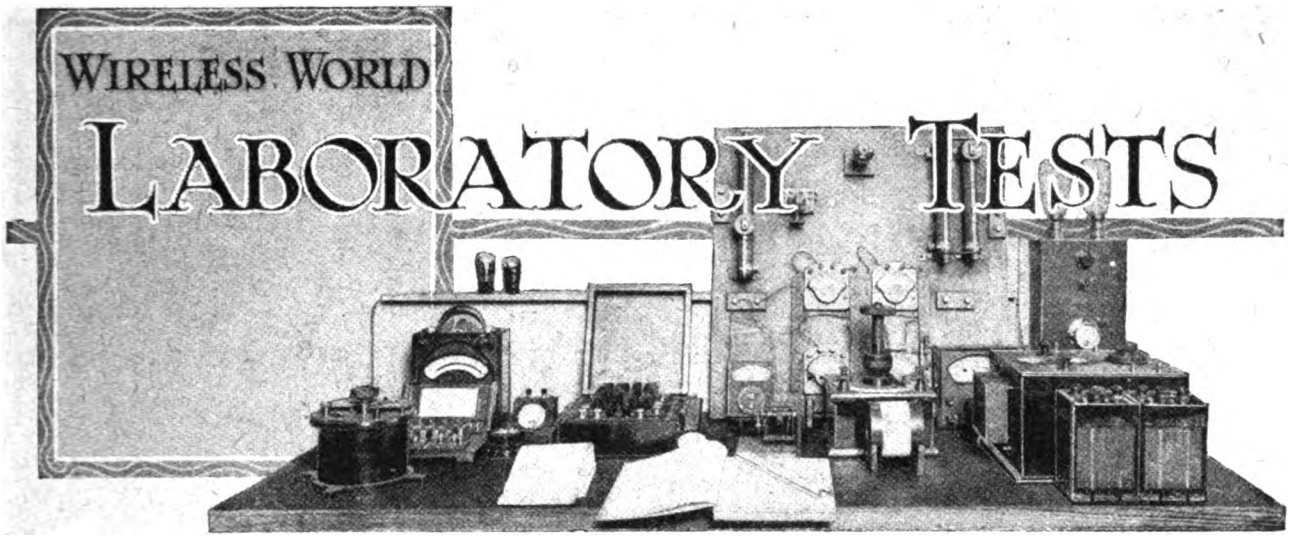
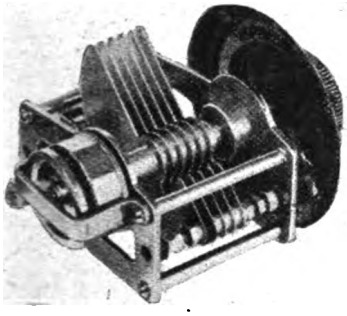


A Review of Manufacturers' Recent Products.

DUBILIER VARIABLE CONDENSER.

A new product of this company is a 0.0001 mfd. variable condenser designed to meet the special requirements of short-wave reception. Wide spacing between the vanes is adopted, but the feature of particular interest is the provision of a small glass ball, in place of the steel ball usually fitted, in the slow-motion drive.



Dubilier special short-wave receiving condenser.

This, it is claimed, eliminates those noises to which a metal-to-metal drive so often gives rise. Single-hole fixing is adopted, and the reduction ratio is approximately 200 : 1.

The measured maximum capacity was found to be 0.000099 mfd., and the minimum capacity 5 micro-mfds. only. The price is 12s. 6d.

The "K.C." drum control triple condenser assembly consists of three "K.C." type condensers—without special slow-motion device other than that obtained by virtue of the large drum controls—mounted on a substantial aluminium frame. The three drum controls are sufficiently close together to enable simultaneous, or independent, control of the three condensers. This is achieved by passing the operating spindle of the extreme outside condenser through the hollow shaft of that adjacent to it. The drum operating this condenser is therefore the centre one of the three.

Normally each condenser has the same capacity, either 0.0005 mfd. or 0.0003 mfd., but for a small extra charge combinations of these capacities can be supplied. The sample tested comprised three 0.0005 mfd. condensers, and measurements made showed that they were for all practical purposes satisfactorily matched. The measured minimum capacity of each was 25 micro-mfds. (this rather high figure is due to the mass of metal comprising the frame and adjacent condensers), while the maximum capacities were found to be 0.000475 mfd., 0.000478 mfd., and 0.000487 mfd. The price is 38s. 6d. in either 0.0005 mfd. or 0.0003 mfd. capacities.

The makers are the Dubilier Condenser Co. (1925), Ltd., Ducon Works, Victoria Road, North Acton, London, W.3.

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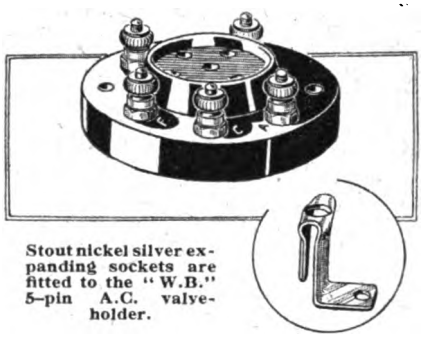
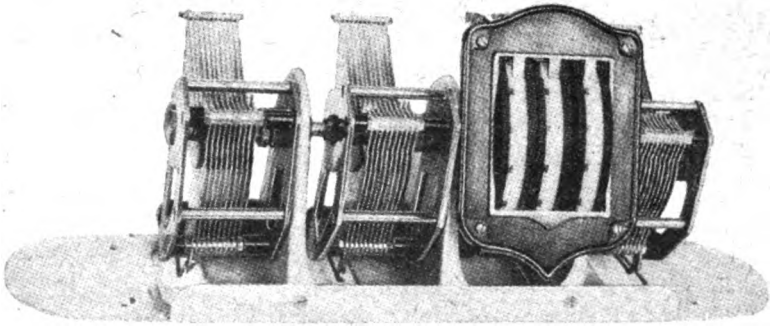
"W.B." 5-PIN A.C. VALVE-HOLDER.

Shortly a new range of indirectly heated A.C. valves will be appearing on the market having a modified arrangement of the pin connections in the base. Four pins are spaced in the orthodox way, whilst the fifth is central. This demands a special base fitting, which is met by the "W.B." 5-pin A.C. valve-holder now on the market. It consists of a moulded bakelite shell with five sockets arranged to take both the new and the present type valves; a similar number of terminals is fitted and appropriately marked. The holder is of the rigid type, not anti-microphonic. Nickel silver expanding leg sockets are fitted. The makers are Messrs. Whiteley, Boneham & Co., Ltd., Nottingham Road, Mansfield, Notts, and the price is 1s. 6d.



Stout nickel silver expanding sockets are fitted to the "W.B." 5-pin A.C. valve-holder.



"K.C." drum control triple condenser—a Dubilier product.

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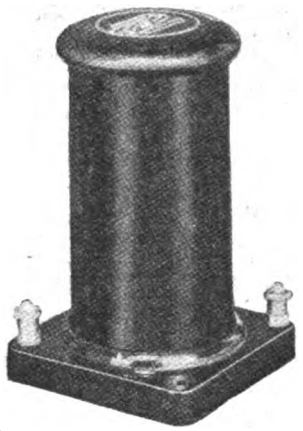
R.I. DUAL ASTATIC CHOKE.

The parallel-feed method of coupling screen-grid valves, in which an H.F. choke is used in conjunction with a coupling condenser to pass on H.F. currents to the tuned grid circuit of the succeeding valve, has had the effect of



The R.I. "Dual Astatic" choke; D.C. resistance 660 ohms.

bringing to light serious defects in certain types of H.F. chokes which give satisfactory results in other circuits. The trouble is due to subsidiary resonances, particularly in the region of 200-500 metres, which causes absorption and, consequently, inequalities in the amplification curve of the H.F. stage.

Messrs. R.I., Ltd., have given this problem their special attention, and have succeeded in producing a choke which does not suffer from these defects. The impedance curve shows that it is entirely free from subsidiary resonances and can therefore be used in screen-grid valve couplings without producing absorption or "blind spots." Under the conditions of the test with an associated capacity of 8 micro-mfd. the maximum impedance is obtained at 1,800 metres, which indicates that the choke can be used for all broadcast wavelengths in common use without the slightest possibility of self-oscillation. Impedance values at a few important wavelengths are as follows:—

Wavelength (metres).	Impedance (ohms).
200	8,020
500	41,500
1,500	280,000

The windings are air-spaced and wound astatically, so that the external magnetic field associated with the choke is reduced to negligible proportions and the possibility of coupling with other coils in the circuit is minimised. The standard choke is 3½in. in height and is mounted in a base 2in. square. A modified design suitable for portable sets is also available.

Naturally, the qualities which make for success in the screen-grid circuit are also advantageous in other circuits, such as the detector with capacity controlled reaction, and the choke can be recommended for universal application. The price is 7s. 6d.

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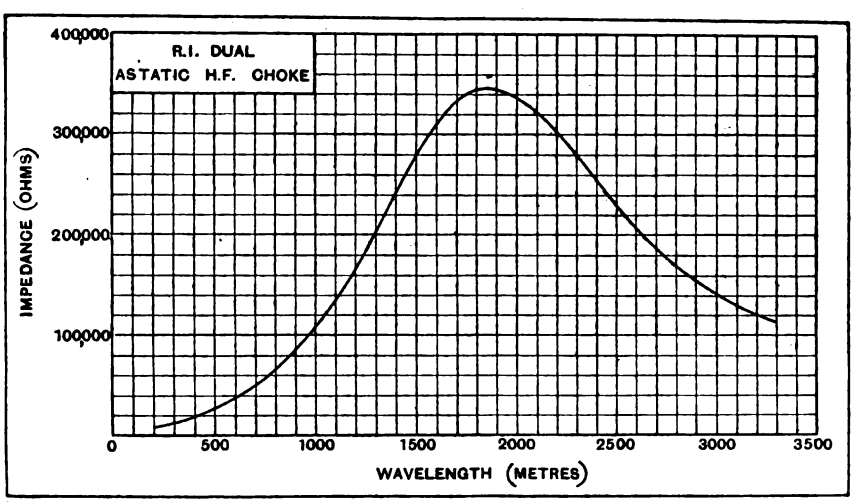


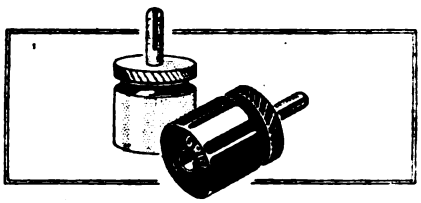
Impedance curve of the R.I. "Dual Astatic" choke; external capacity 8 micro-mfd.

BELLING-LEE WANDER PLUGS.

The main feature of this wander plug is that provision is made for gripping the silk covering as well as the wire when ordinary lighting "flex" is used. The result is a neat and tidy termination to the H.T. and grid bias leads. To attach the wander plug unscrew the cap, thread the flex through, and pass the bared wire through the small hole in the loose washer. When the head is replaced, the wire and covering will be firmly gripped and no frayed ends visible.

An improvement of no less importance is the nature of the prongs. These are not turned and split, but are made from "D"-section hard-drawn brass wire, and it is claimed that this method of construction imparts to the prongs greater resiliency, since the springiness of metals is largely due to the hard crust which is generally removed in the tuning process.

The plugs are small and particularly suitable for use in portable sets where the clearance above the top of the battery is not too great. Indicating lettering is engraved on the caps, and fifteen variations are available.



Belling-Lee indicating wander plugs.

The makers are Messrs. Belling and Lee, Ltd., Queensway Works, Ponders End, Middlesex, and the price is 4½d. each.

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"SINQUERS."

The introduction of small floats into accumulator cells provides a visual indication of the state of the battery, but hitherto these have not been available to the public. Messrs. Fiddian, Bawtree and Co., Gem Works, Oakhill Road, Sutton, Surrey, have recently placed on the market a special compound from which small balls to act as charge indicators can be made quite easily. The compound is supplied in the form of discs 1½in. in diameter and ¼in. thick. These are supplied in red and blue colours, and when placed in warm water become sufficiently soft to work into balls.

A small pellet of each colour, dropped into a fully charged accumulator, will float on the surface of the acid, but if the cell is half discharged the red ball only will float, while the blue will sink. Should both balls sink, the battery requires charging forthwith.

Tests made with this compound showed that the makers' claim is fully substantiated by hydrometer readings of the acid strength at various positions of the pellets. The blue ball commenced to sink when the S.G. of the acid dropped to 1,215 (corresponding to half charge with a cell filled with normal strength acid). The red commenced to go down when the S.G. of the electrolyte was down to 1,175.

It will be necessary to raise the acid level in some types of cell so as to leave at least half an inch above the top of the plates for the "Sinquers" to perform in.

The compound is supplied in small cartons, each containing a red and a blue disc, at the price of 1s., or by post 1s. 3d.

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CORRECTING NOTE.

When referring to the products of the Concordia Electric Wire Co., Ltd., in the issue of July 17th, the address was given in error as nr. Birmingham. It should have been New Sawley, nr. Nottingham.

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News from All Quarters: By Our Special Correspondent.

A Hard-worked Announcer.—Trials of Programme Preparation.—Describing a Car Race.

A Visitor from Denmark.

A stir was created among the announcing staff at Savoy Hill last week by the arrival of Mr. Carl F. Schionning, nor did the commotion subside when Mr. Schionning passed a few remarks on what he saw. Mr. Schionning, who is the chief announcer in the Danish broadcasting service, expressed amazement at the general efficiency of British broadcsting, but he stated in no uncertain terms that he envied the British announcer.

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The Day's Work.

From Mr. Schionning's account of his own duties, it would seem that when he tumbles into his bed in the small hours he has every right to "call it a day." Every day, Sundays included, he begins work at 9 a.m. and, on alternate days, continues his announcing duties until midnight. He can call every second day his own after 5 p.m.

In addition to announcing, he conducts rehearsals and auditions, engages artists, assesses their respective programme value and pays them accordingly.

All this work is carried out at the headquarters at Copenhagen, whence all Danish programmes are broadcast or relayed to Kalundborg and other relay stations.

oooo

A Comparison.

Beside this prodigious output of individual effort, the job of the B.B.C. announcer is undoubtedly a "walk-over," but there must be very few listeners who would claim that the payment of their annual licence fee entitled the public to extract so much daily toil from one person.

A B.B.C. announcer averages eight hours daily, and even if he is not fully occupied all that time, it is worth remembering that the work is irregular and calls for a good deal of private inconvenience to keep up the flow of programmes at hours which in most businesses would be regarded as "unreasonable."

oooo

Plans That Go Awry

By the way, the Programme Department, probably suffering from the effects of the heat wave, has had an attack of statistical fever. An average has been struck over the past two or three months showing that every week approximately 111 alterations are made in the programme list as it is originally conceived.

This means, in effect, that 16 "best-laid schemes . . . gang agley" every day, and may serve to explain why members of the Programme Department nearly always wear a hunted look just before the programmes go to press

FUTURE FEATURES.

London and 5XX.

AUGUST 4TH.—Boy Scouts' Association World Jamboree, Thanksgiving Service from Arrowe Park, Birkenhead. Addresses by Archbishop of Canterbury and Sir Robert Baden-Powell.
AUGUST 7TH.—Sing-Song relayed from Duke of York's Camp, New Romney.
AUGUST 8TH.—"The Fountain of Youth," comic opera by Alfred Reynolds.
AUGUST 10TH.—Opening Night of Promenade Season, Queen's Hall.

Daventry 5GB.

AUGUST 6TH.—"Wurzel-Flummery," a comedy by A. A. Milne.
AUGUST 7TH.—Military Band Concert from Leamington Spa.

Cardiff.

AUGUST 7TH.—Two plays relayed from Citizen House, Bath.

Manchester.

AUGUST 5TH.—Running Commentary on Yorkshire v. Lancashire County Cricket Match, by Mr. F. R. Stainton.
AUGUST 8TH.—Eisteddfod Concert from Liverpool.

Newcastle.

AUGUST 8TH.—Band from North-East Coast Exhibition.

Glasgow.

AUGUST 6TH.—Scottish Orchestral Concert

Aberdeen.

AUGUST 7TH.—"Wi' the Jocks in France," by Arthur Black.
AUGUST 9TH.—Song and Story of the Gael.

Belfast.

AUGUST 6TH.—Irish Variety Programme.

Seeking Fresh Talent.

A more harassing job, though than that of "Programmes" belongs to the Booking Department, whose members go out at the behest of the Programmes Department to tap fresh sources of talent. This calls for resource, discrimination and moral courage, particularly the last, as there are certain sources of talent which have to be dammed, not tapped.

By Air to the Microphone.

Mr. S. C. H. Davis, of *The Autocar*, will broadcast from a Glasgow studio an eye-witness account of the International Motor Road Race for the R.A.C. Tourist Trophy, which will be run in Ulster on August 17th. The description will be sent out from all stations except 5GB at 10 o'clock on the evening of the 17th.

Mr. Davis is competing in the race, and in order that he may reach Glasgow station in time to broadcast on the same day, the B.B.C. has arranged with the Scottish Flying Club for an aeroplane to fly him from Belfast to Renfrew aerodrome, whence a car will convey him to Glasgow. Mr. Davis, who will leave Belfast immediately after the race, will prepare his broadcast while flying across the Irish Sea.

oooo

A Cricket Commentary.

County cricket does not usually lend itself to the broadcast commentary, but an exception is to be made in the case of the Yorkshire and Lancashire match on August 5, when a running commentary by Mr. F. R. Stainton will be relayed from the Bradford cricket ground to all stations in the Northern region.

oooo

A Shakespeare Night.

A broadcast version of Shakespeare's "King Henry VIII," in seventeen scenes, will be heard from 2LO and 5XX on August 14. The play, which will occupy two hours, has been adapted by Dulcima Glasby and will be produced by Howard Rose, who forsook the legitimate stage some three years ago to join broadcasting, and whose productions for Savoy Hill now run into several hundreds.

oooo

National Programme from the North.

A musical feature of outstanding importance is being contributed by the North Region to the national programme on August 7th, when listeners to London and Daventry, as well as to Northern stations, will hear a Symphony Concert, conducted by Sir Hamilton Harty, from the Main Studio at Manchester. The programme includes a concerto for violin and orchestra, written by Sir Hamilton himself. The solo part will be played by Alfred Barker, with the Northern Wireless Orchestra accompanying.

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The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to The Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS.

Sir,—As a regular reader of your valuable paper may I be allowed to say a few words on the question of status? It is assumed by the majority of your correspondents that the amateur generally is in no way to blame for the present state of affairs, which, in my opinion, has been brought about largely by at least 50 per cent. of the present-day amateurs not truly realising what they are granted their licences for.

The so-called experiments relating to this 50 per cent. consists of, mainly, "brass pounding," with no real object in view, collecting childish "QSL cards," generally making uncontrollable nasty noises, or attempting to send wheezy gramophone records. I therefore support the authorities in their administration which will probably not be relaxed until the amateurs as a whole do something useful. I am not, of course, referring to pioneers, but more to the younger members of the fraternity. It is pleasing to see, however, that certain responsible men are at last getting together for serious work. *This only will help to raise the amateur status.* "AN OBSERVER."

London, N.17.

Sir,—Having held the position of Hon. Secretary to the Incorporated Radio Society of Great Britain during the negotiations with the Post Office authorities regarding the application of the Washington Report, I feel that I should be permitted to reply to your correspondents who have communicated with you upon this matter.

The existing conditions for amateur transmitters were agreed after prolonged exchange of views between a special committee appointed by the R.S.G.B. and the Post Office, and finally resulted in practically every point of the Washington Report being conceded, the only point not allowed being an application for reduction of the tolerances or safety limits upon the various bands. The negotiations resulted in the free transmission of "unimportant private messages" and the use of the 21- and 4-metre bands by all transmitters, the use of the very short waves having only previously been enjoyed by a few. In effect the R.S.G.B. were quite satisfied with the result of the discussions.

It must be remembered that the law regarding amateur transmissions is very different in this country to elsewhere. Here the provisions of the Telegraph Act are in force to preserve the Crown monopoly of the sending of all messages from one party to another. The facilities granted to amateurs can therefore be regarded as concessions for experimental work under the Act. The sending of free traffic messages, as in the U.S.A. and as suggested by one of your correspondents, would be an impossible grant even for the Postmaster-General without the Act being repealed. Consequently the complaint of the correspondent should be directed rather against the Government than the Postmaster-General, who is in reality only administering the powers vested in him to guard.

Nobody would envy the Postmaster-General in his work concerning the issue of licences. He has to use every precaution within his power to preserve his rights and to grant concessions only to those whom he has good grounds to believe will not abuse them. In this respect obviously such organisations as the A.B.R.S. and the R.S.G.B. must be of great assistance to him upon account of the assurance they can give, being in close touch with their members.

Applications to the R.S.G.B. for recommendations for special facilities have always been considered by a special committee, and in very few cases have they been rejected. In most instances the applicant failed to supply evidence warranting the use of the special powers sought, while in others the Society felt that endorsement would jeopardise the trust imposed in them.

In conclusion, I can only state that all negotiations with the Post Office authorities which passed through my hands were conducted in the most friendly spirit and with the utmost courtesy. H. BEVAN SWIFT,

Act. Vice-president, Inc. Rad. Soc. of Great Britain.

Sir,—We wish to show our appreciation of the stand you are taking for amateur radio.

We cannot help thinking how much better it would be on both sides if the amateur radio movement was given recognition by the Government, and an emergency network of stations built up, ready to deal with traffic when required.

Controlling regulations would, of course, be drawn up, and if the Government was afraid that transmitters were avoiding paying for telegrams in this way, traffic forms could be issued or sold, a check being made in this way of the traffic dealt with. This system is, we believe, carried out with success by the A.R.R.L. in America.

Another point is that the standard of amateur transmissions in Britain is as high, if not higher, than in any other part of the world, and for reliability cannot be beaten. When one hears so-called mobile or emergency stations sending out A.C. signals on any frequency they wish to use one wonders what the amateur has done to warrant the treatment that he is given in this country.

Trusting that you will continue to give the matter prominence, as you successfully did Empire broadcasting,

CYRIL S. HUNT, G6NT.
R. A. MINTER, G5RM.

JUNK.

Sir,—Mr. Kendall's suggestion is excellent.

I am sure that there are any number who would be only too glad to give their discarded apparatus for the furtherance of hospital work.

Any quantity may be addressed to King's College Hospital, London, S.E.5. C. E. A. BEDWELL,
House Governor.

A NUT CONVENTION.

Sir,—Might I take the liberty of suggesting that your esteemed journal would earn the gratitude of all set builders if you would arrange with the component manufacturers to use standard sizes of hexagon nuts for terminals, instead of the multitude of various forms and sizes of milled edge round terminals and nuts.

From a manufacturing point of view this matter contains no difficulties; nuts can be cut off from ordinary hexagon rolled brass stock cheaper than they can be shaped up from round stock.

If we had standard nuts we set makers could then obtain special tools that would enable us to tighten up our out-of-the-way connections without any loss of time or temper.

Alexandria, Egypt. "MAHANDIS."

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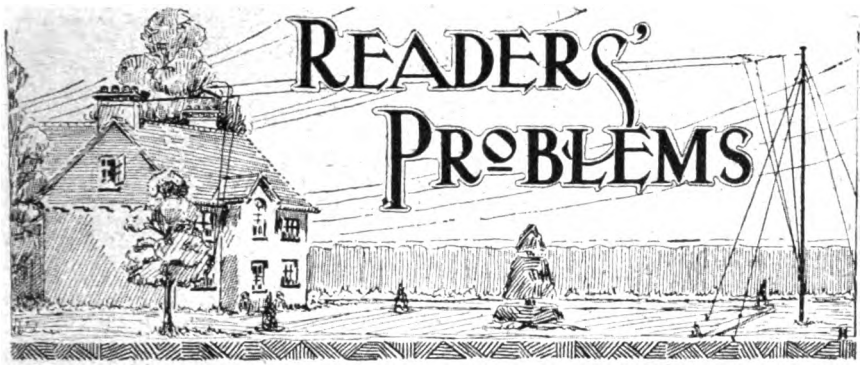

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Too Much Magnification.

I am sending you a circuit diagram of my proposed A.C. mains receiver, and should be obliged if you would let me have your comments on the general suitability of the arrangement. In several articles in "The Wireless World" stress has been laid on the fact that it is often unwise to strive after maximum amplification from the L.F. side of the average set; with a view to avoiding risk of L.F. oscillation, I have decided to use choke coupling between the detector and first L.F. amplifier, as this will give less magnification than a transformer. It is with regard to this part of the circuit that I should especially appreciate any criticism. B. S. R.

The diagram of a four-valve mains set submitted by our correspondent shows a single transformer coupled H.F. stage (S.G. valve) followed by an anode bend detector and two L.F. stages, choke and transformer coupled (in that order). Cosmos A.C. valves are to be used throughout, and the diagram indicates that both screening and decoupling are to be unusually complete.

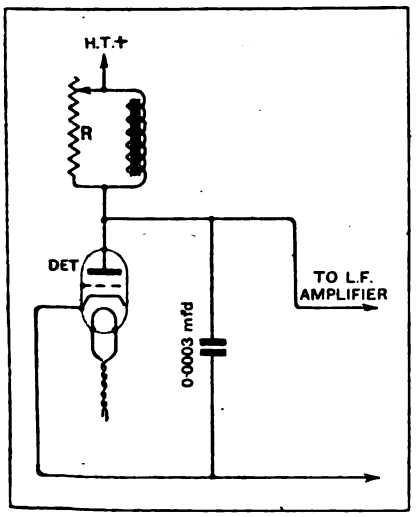

Fig. 1.—Resistance volume control for L.F. choke coupling.

While choke coupling will give less magnification than a transformer, it should be pointed out that the overall magnification of the L.F. side of the receiver with the modern valves specified will be very large; in spite of this, stability may be achieved, thanks to the elaborate precautions taken, but there is some possibility of another trouble against the occurrence of which no measures seem to be proposed. This is associated with the anode bend detector; a rectifier working in this way, as is well known, requires a large input for its satisfactory operation, and consequently it can hardly be followed by a high magnification L.F. amplifier in which the voltage-handling capabilities of the output stage are more or less limited. As frequently pointed out, in these circumstances it is essential to provide some means whereby surplus amplification of signals of great or medium strength may be thrown away—when listening to really distant transmissions, "quality" considerations generally fall into the background—and we suggest that you should fit a variable resistance of some 200,000 ohms' maximum value across the choke. This form of control, which is nowadays generally recommended for L.F. transformer coupling, is quite satisfactory in this particular case. The method of connection is shown in Fig. 1.

○○○○

Compromise in Design.

Although my "S.G. Regional" provides amply loud signals from Daventry 5XX, I find that volume from several of the other long-wave stations is hardly adequate. Is there any simple way of increasing its sensitivity on this band? I should make it clear that only a small increase in magnification is necessary. F. S. W.

It should be possible to make an appreciable increase in H.F. magnification on the long wave side—but, of course, at the expense of some selectivity—by increasing the number of primary turns on the long-wave transformer. Instead of winding this section in three slots only, we suggest that you should deepen the fourth slot (counting from the low-potential end), and in the lower part of this deepened slot will be wound another primary section identical with the others. A small loss in selectivity should not trouble you in your (wirelessly) remote situation, and in any case interference between long-wave stations is not so severe as at the time when the set was designed.

○○○○

Faulty Insulation?

My "Kilo-Mag Four" receiver, after working satisfactorily for some time, seems to have developed a fault. The set has been modified by the insertion of a low-reading milliammeter in series with the detector anode circuit in the manner suggested in recent articles; normally, the meter indicates a reading of about 0.25 milliamps when bias is set for best rectification. Now, with the same bias, current is increased to about 2 milliamps (not constant), and the signals from distant stations are almost unreceivable.

The great increase in detector anode current is observed whether or no signals are coming in, and the usual tests fail to reveal any fault; batteries are in order, and the valve itself functions properly in a similar set. Can you suggest what is wrong? P. S. C.

This is a puzzling fault, but we are fairly certain that there is a simple explanation. You have probably omitted to test the insulation resistance between the windings of your second H.F. transformer; we think it likely that you will find that this has become defective, and that there is a considerable leakage to earth from the source of H.T. supply. Current flowing through this leakage path will give rise to a difference of potential across the ends of the decoupling resistance in the grid circuit, and consequently a positive voltage in opposition to that impressed by the grid battery will be applied to the detector grid, giving rise to the effect you describe.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Heat-resisting Former.

I am about to make a wire-wound re reducing resistance for accu charging purposes, and, in t terests of economy, propose t gauge of wire that, according issued by its manufacturers, come quite hot. Will you re a suitable heat-resisting ma the former on which the c wound?

A number of substances spe for this purpose are availabl suggest that you should c dealer. If he has nothing s might use a length of metal t over with sheet-asbestos. this sort is quite satisfact and the materials for it a tainable

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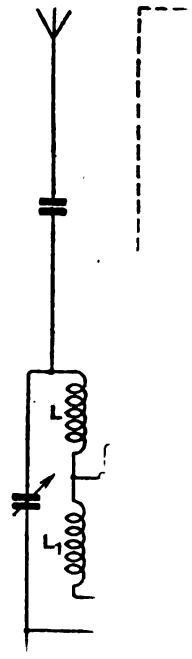
Valve Character

A certain valve is rat impedance of 12,000 *volts* 100, *grid vol imply that these its best working c under the impres —either positiv always necessary*

No. Many n adopted these condi



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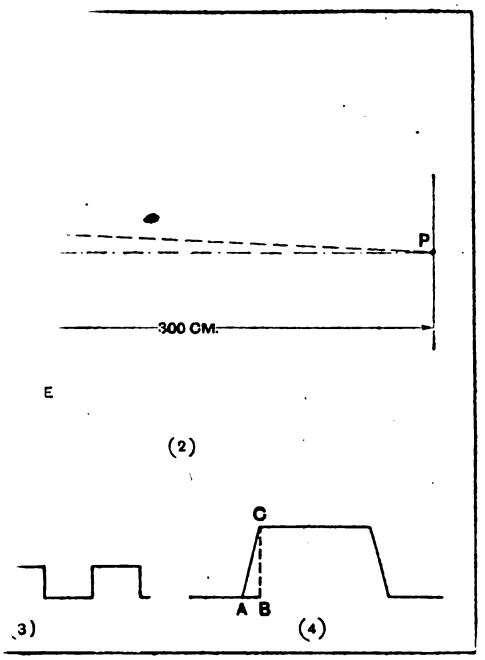
rs and Amplifiers.—

om the microphone amplifier and to the grid of the power valve. ow confronts us is to reproduce a



showing small rigid disc in infinite baffle. The are propagated equally in all directions at all ncles. In (3) the waveform obtained from relay shown. Diagram (4) illustrates the finite time the current to reach the value BC. The smaller val AB, the more rapid the rise in current and the frequency of the component sine waves involved.

identical in shape with that of the voltage d to the grid of the power valve.

ticle cited above we saw the result of a square- aveform as reproduced by various loud The initial rise in current from zero to a was re- — with gree of does not us at the —but the gm in- f remain- a definite a due to ady current s winding, ded to exe- a complex ed vibration ne form de- d in Fig. 1. eover, instead faithful copy of the transient—which might have n due to a pistol shot—we chiefly got the natural illations of the diaphragm. This being the case, it of little use bothering to ascertain whether the initial rt of the transient was faithfully reproduced or not.

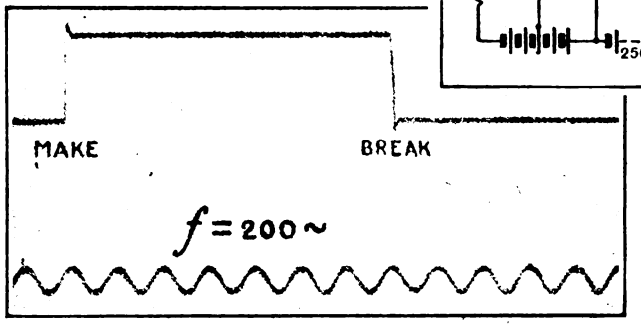
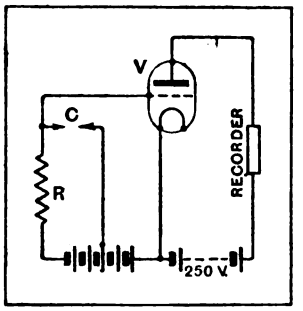


Fig. 5.—Diagram illustrating disposition of apparatus for applying square topped waveform to grid of valve. The grid bias is reduced by closing the relay contacts C through a high resistance R. V is an LS5A valve. The waveform applied to grid of valve containing apparatus under examination is shown in the lower illustration.

If the natural oscillations of the loud speaker had been negligible then we should have been able to probe the problem regarding the degree of agreement between the shape of the original waveform as applied to the grid of the valve, and that propagated from the loud speaker and registered by the microphone at some point on the axis of the speaker. As this phase of the subject is of more than passing interest we can profitably pause to contemplate the fundamental principles of the situation. We shall assume that the loud speaker is represented by a rigid disc one centimetre in diameter situated in a flat baffle of infinite extent as shown in Fig. 2. There is no appreciable constraint at the periphery of the disc, so that the system has no natural frequency within the range of audibility. The disc is to be driven by some hypothetical agent exerting a force thereon, whose waveform is a replica of the voltage applied to the grid of the power valve.

When the Reproduction of Transients would be Perfect.

Under such conditions the sound waves are propagated equally in all directions, and the mass to be added to the disc by virtue of its motion in the air is constant. Thus the total mass of the disc, *i.e.*, its ordinary or gravitational mass plus the accession to inertia,[2] remains unaltered over the range of audible sounds. Over three years ago I investigated the distribution of pressure due to the sound waves caused by a rigid disc vibrating in an infinite baffle.[3] In *The Wireless World*, March 30th, 1927, I gave a formula for the sound pressure on the axis at a distance of eight or more times the diameter of the disc. Suppose in the present case we consider a point on the axis distant three metres from the disc, *i.e.*, 300 diameters. At this point the sound pressure due to the vibrating disc is directly proportional to the axial acceleration of the disc, *i.e.*, at a distance of 600 diameters the sound pressure would be halved. Bearing in mind that we have assumed the force driving the disc to be proportional to the voltage applied to the grid of the power valve—since the electric and mechanical waveforms are identical—what precisely can we deduce concerning the acoustic waveform of a transient at a point 300 diameters from the disc? Since the distances OP and AP (Fig. 2) are almost identical, sound waves of audible frequencies radiated from various parts of the disc arrive in phase at P; this would not be the case with a large disc at, say, 10,000 cycles and three metres distance. Now from the mathematical analysis cited above, the acoustic pressure at all



[2] See *Wireless World*, March 23rd and 30th, 1927.
[3] See also Proc. Roy. Soc. A Vol. 122, 1929.

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Heat-resisting Former.

I am about to make a wire-wound voltage-reducing resistance for accumulator charging purposes, and, in the interests of economy, propose to use a gauge of wire that, according to data issued by its manufacturers, will become quite hot. Will you recommend a suitable heat-resisting material for the former on which the coil will be wound? M. S. G.

A number of substances specially made for this purpose are available, and we suggest that you should consult your dealer. If he has nothing suitable, you might use a length of metal tube wrapped over with sheet-asbestos. A former of this sort is quite satisfactory and safe, and the materials for it are readily obtainable

oooo

Valve Characteristics.

A certain valve is rated as having an impedance of 12,000 *ohms at "anode volts* 100, *grid volts* 0." *Does this imply that these voltages represent its best working conditions? I was under the impression that grid bias —either positive or negative—is always necessary in modern circuits.* R. P.

No. Many manufacturers have adopted these conditions as a standard on which to base their "impedance" and "slope" ratings, but nowadays a valve is seldom operated with a zero grid—except in case of special valves, in which grid current starts "late."

Generally speaking, the effect of applying grid bias will be to raise impedance, but it must be remembered that a considerably higher anode voltage than 100 is generally used, with the result that impedance is again brought down to something approximating to the rated figure, which is consequently a useful guide.

oooo

A Super-selective Set.

My four-valve receiver, with two H.F. stages, has never given really satisfactory results, and after careful consideration of its design I am forced to the conclusion that it has several grave shortcomings, and have decided to rebuild it entirely. My main object in writing to you is to ask whether you recommend the use of a separately tuned aerial in a "2 H.F." set; I have recently been trying a two-circuit tuner in a considerably less ambitious receiver, and am greatly attracted by it. Will you please give me a circuit diagram showing the simplest possible method of switching the aerial tuner (if my proposed plan is approved), and also giving the complete connections of the H.F. amplifier? A. C. P.

A separately tuned aerial circuit will better the selectivity of any set, although your 2-stage H.F. amplifier will stand less in need of improvement in this way than an arrangement with a lesser number of tuned circuits. Accordingly your proposed scheme is to be recommended (if you do not object to four tuning controls), and we give in Fig. 2 the circuit diagram you require. We have indicated a simple but quite effective method of arranging the tuned aerial and secondary circuits, in which wave-changing is effected by a three-pole switch, the left-hand blade of which is arranged to short-circuit the long-wave loading coil L_1 when the switch is in the short-wave position.

L_2 and L_3 are, respectively, short-wave and long-wave grid coils, to which the tuned aerial circuit is coupled by the well-known auto-transformer arrangement.

We fear that it would be beyond the scope of the Information Department to go thoroughly into the question of the complete H.F. amplifier; the receiver you propose to build is ambitious, but sufficient information has been published in recent articles to enable you to make a satisfactory choice of values and layout.

oooo

Relative Cost.

Is it more economical to feed a receiver from an eliminator supplied through A.C. or D.C. mains? It seems to me that the latter should provide a much more economical source of supply, as no energy is taken from the mains for heating the filament of a rectifier valve. S. F. J.

If your query relates to the supply of both H.T. and L.T. current, there can be little doubt that with the arrangements customarily used an A.C. supply is much more economical. We believe, however, that you have in mind only the question of anode current feed; in this case, speaking generally, the efficiency of the D.C. supply is slightly higher, but this is a very small matter, as the energy required for heating a rectifying valve filament or that lost in other types of rectifier not requiring heating is extremely small

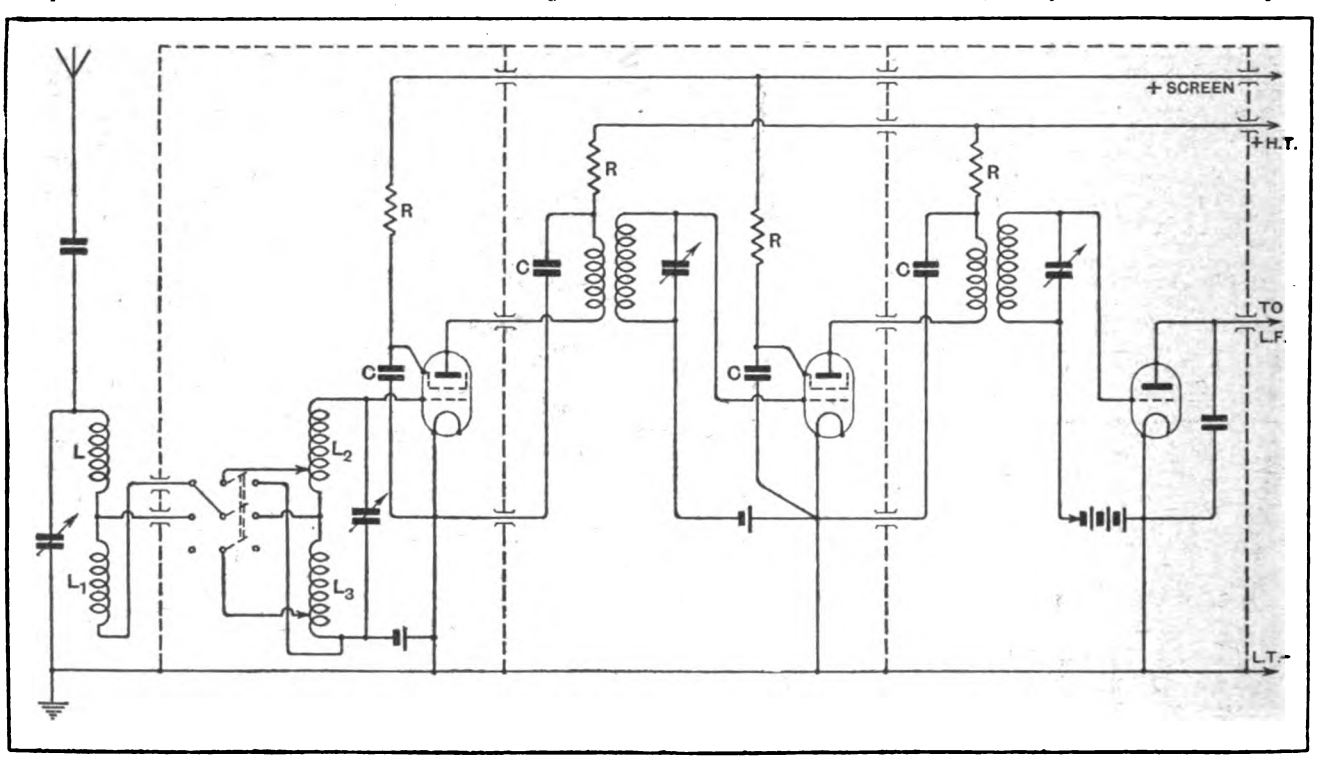

Fig. 2.—Two-stage H.F. amplifier with two-circuit aerial tuner. Transformer waveband switching is omitted.

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The Wireless World

AND RADIO REVIEW

(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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SELECTIVITY.

WE learn that the equipment of the new 2LO is already undergoing tests and that soon the needle of the aerial ammeter will move across the scale. So great is the power of this station that tens of thousands of listeners are turning over in their minds the changed conditions of reception that will soon come about. To be tied to the programme of the local station is distressing, yet it is feared that many listeners interested primarily in distant station reception will need to redesign their sets completely. While we have all learned to appreciate the excellent quality obtainable with a local station receiver we are not anxious to give up our interest in tuning to the foreign programmes. Foreseeing these impending difficulties attention has been turned in these pages to the design of long-range selective sets, while readers have been quick to grasp the full significance of the recent articles dealing with H.F. valves and amplifiers. Facts and figures have shown that screen-grid valve performance has passed beyond recognition as compared with previous standards, while new design data, both theoretical and practical, is bringing about a marked improvement in the range of reception. Thus to maintain our contact with the distant transmissions in the face of local interference we shall need sets giving more H.F. amplification than previously and possessing a higher degree of selectivity. New designs will include complete stage screening, coils of good efficiency, and a possible revival of gang control, while there is likely to be a passing out of the use of reaction.

Valve designers and set manufacturers are considering the relative merits of obtaining selectivity simultaneously with amplification by the use of several stable H.F. stages of moderate gain as against the highly efficient stage associated with a tuned filter. Wave-traps and filters supplied as auxiliary units to attach to existing sets are to become popular. Stage gain and selectivity are linked together, the one being modified by the other. When a statement is made as to overall amplification it is important that it should be associated with a figure indicating the degree of selectivity that can be expected. Units of selectivity are yet to be devised as a means of expressing sharpness of tuning. To set up a standard of selectivity is no easy matter, and the problem becomes highly complex when applied to a multi-stage H.F. amplifier or when interelectrode capacity is acting as a stimulant to amplification.

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WIRELESS AND THE MUSIC TRADE.

RUMOURS are current that as a result of the recent linking together of the Marconi and Gramophone Companies the sale of wireless sets may pass into the hands of the music trade, and that after a while we shall go to the music shop to buy our valves. Such a change, however, need not be feared. The working and maintenance of wireless apparatus, combined with the difficulties of servicing, are far too complex to be handled by an inexperienced retailer, and for him to attempt to sell to the equally inexperienced customer is truly a case of the blind leading the blind.

Let us leave wireless to the wireless trade and avoid the mistake of arousing prejudice when presenting new equipments to the wireless-interested public. The voice of the enthusiast is a strong one, and the unsatisfactory results of the handling of radio gear by unskilled salesmen will rouse his resentment.

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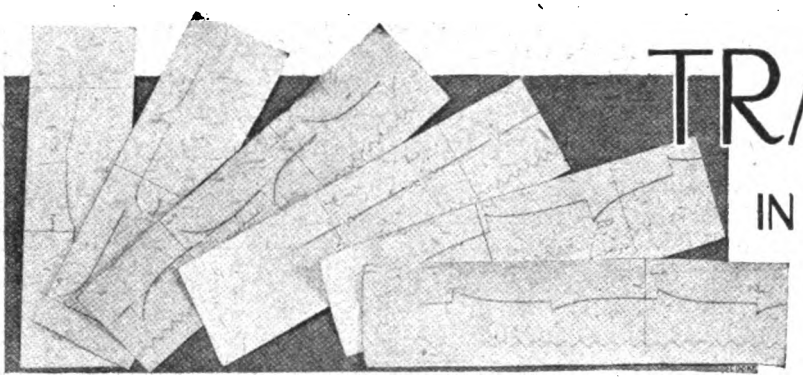

TRANSIENTS IN LOUD SPEAKERS AND AMPLIFIERS

How Sudden Changes in Sound Intensity Affect the Amplifier.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

IN the first article on Transients[1] we were mainly concerned with the influence of a sudden impulse upon a loud speaker. If sudden sounds like those due to gun-fire, the piano, hand-clapping, etc., are accompanied by the natural oscillations of the loud speaker, it is clear that *transients of this nature* must always be reproduced with considerable distortion. The superposition of the natural oscillations of a loud speaker is not the only way in which distortion of a transient can be caused. In order to indicate the nature of the problem it will be well to start from the beginning.

Suppose a sudden sound occurs in room where a microphone is situated. The waveform of the sound will in general be modified by the acoustic properties of the room. If the sound were due to a pistol shot, it is clear that the effect on the microphone would be totally different (a) for a room with bare cement walls, (b) in a room whose walls, etc., were heavily lined with cotton waste. The sound of a pistol shot is obviously a transient, and its waveform as perceived by the microphone will differ according to the type of room in which the pistol is fired. This is due to the effect of reflection from the walls which causes the sound to be prolonged and modified in waveform. With a hard cement wall the sound will persist quite a long time. This case is analogous to the loud speaker transients obtained when the current is suddenly sent through the winding. The diaphragm moves outwards very quickly and afterwards settles down to a series of damped oscillations, as shown in Fig. 1. When a pistol is fired in a room with cement walls there is a sudden rise in air pressure, which travels *direct* from the muzzle. This direct wave affects the microphone and causes a rapid rise in current therein. Thereafter the pressure wave having been reflected from the six sides of the enclosure is modified in shape, and can be considered to be due to the combined effect of the natural oscillations of the room.

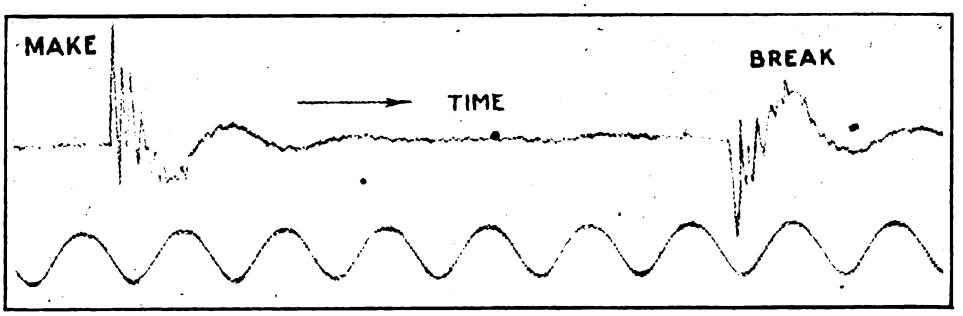

Fig. 1.—Acoustic output from experimental reed-driven loud speaker with large conical diaphragm. The main diaphragm oscillation persists for about two oscillations. Its frequency is about 100 cycles. The higher frequency is about 1,800 cycles.

The Effect of Reverberation.

In free, open space it is clear that only the direct pressure wave would actuate the microphone, since there is no room or enclosure to cause reverberation. When the enclosure is highly damped with cotton waste the sound will decay rapidly and resemble that obtained in free space. Thus the actual shape of an acoustic transient depends upon the external conditions with which its occurrence is associated.

We can, if we choose, regard the true transient as the sound obtained in either the open air or in a very heavily damped room. On the other hand we can simply regard the sound of the pistol shot, however modified by surroundings, to be a form of transient. Taking the latter view we obtain a definite waveform of the sound due to the pistol shot in a certain room. Since the size of the microphone is comparable with the wavelengths of the higher frequency components of the sound, there will be a certain degree of distortion. The result is that we obtain an electric current in the microphone whose waveform is modified by its presence in the sound field. For the time being we shall disregard the variation in waveform caused by the microphone and consider the shape of the desired transient to be

[1] *Wireless World*, April 3rd and 10th, 1929.

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Transients in Loud Speakers and Amplifiers.—

that which emanates from the microphone amplifier and is applied as a voltage to the grid of the power valve. The problem which now confronts us is to reproduce a sound wave identical in shape with that of the voltage wave applied to the grid of the power valve.

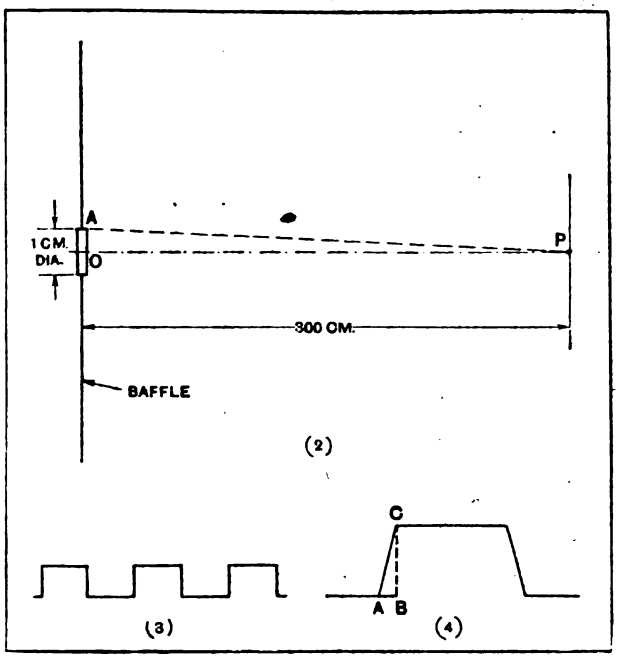
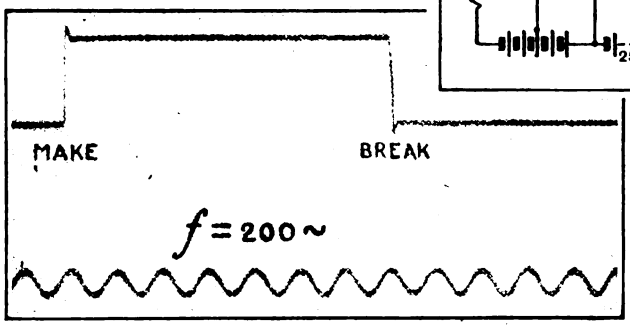


Diagram (2) showing small rigid disc in infinite baffle. The sound waves are propagated equally in all directions at all audible frequencies. In (3) the waveform obtained from relay contacts is shown. Diagram (4) illustrates the finite time (AB) taken for the current to reach the value BC. The smaller the time interval AB, the more rapid the rise in current and the greater the frequency of the component sine waves involved.

In the article cited above we saw the result of a square-topped waveform as reproduced by various loud speakers. The initial rise in current from zero to a maximum was reproduced — with what degree of precision does not concern us at the moment—but the diaphragm instead of remaining in a definite position due to the steady current in its winding, proceeded to execute a complex damped vibration of the form depicted in Fig. 1. Moreover, instead of a faithful copy of the transient—which might have been due to a pistol shot—we chiefly got the natural oscillations of the diaphragm. This being the case, it is of little use bothering to ascertain whether the initial part of the transient was faithfully reproduced or not.



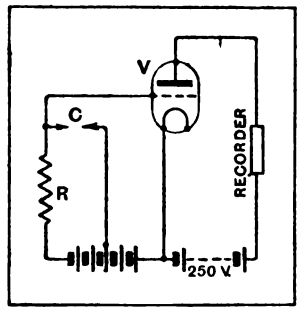


Fig. 5.—Diagram illustrating disposition of apparatus for applying square topped waveform to grid of valve. The grid bias is reduced by closing the relay contacts C through a high resistance R. V is an LS5A valve. The waveform applied to grid of valve containing apparatus under examination is shown in the lower illustration.

If the natural oscillations of the loud speaker had been negligible then we should have been able to probe the problem regarding the degree of agreement between the shape of the original waveform as applied to the grid of the valve, and that propagated from the loud speaker and registered by the microphone at some point on the axis of the speaker. As this phase of the subject is of more than passing interest we can profitably pause to contemplate the fundamental principles of the situation. We shall assume that the loud speaker is represented by a rigid disc one centimetre in diameter situated in a flat baffle of infinite extent as shown in Fig. 2. There is no appreciable constraint at the periphery of the disc, so that the system has no natural frequency within the range of audibility. The disc is to be driven by some hypothetical agent exerting a force thereon, whose waveform is a replica of the voltage applied to the grid of the power valve.

When the Reproduction of Transients would be Perfect.

Under such conditions the sound waves are propagated equally in all directions, and the mass to be added to the disc by virtue of its motion in the air is constant. Thus the total mass of the disc, *i.e.*, its ordinary or gravitational mass plus the accession to inertia,[2] remains unaltered over the range of audible sounds. Over three years ago I investigated the distribution of pressure due to the sound waves caused by a rigid disc vibrating in an infinite baffle.[3] In *The Wireless World*, March 30th, 1927, I gave a formula for the sound pressure on the axis at a distance of eight or more times the diameter of the disc. Suppose in the present case we consider a point on the axis distant three metres from the disc, *i.e.*, 300 diameters. At this point the sound pressure due to the vibrating disc is directly proportional to the axial acceleration of the disc, *i.e.*, at a distance of 600 diameters the sound pressure would be halved. Bearing in mind that we have assumed the force driving the disc to be proportional to the voltage applied to the grid of the power valve—since the electric and mechanical waveforms are identical—what precisely can we deduce concerning the acoustic waveform of a transient at a point 300 diameters from the disc? Since the distances OP and AP (Fig. 2) are almost identical, sound waves of audible frequencies radiated from various parts of the disc arrive in phase at P; this would not be the case with a large disc at, say, 10,000 cycles and three metres distance. Now from the mathematical analysis cited above, the acoustic pressure at all

[2] See *Wireless World*, March 23rd and 30th, 1927.
[3] See also Proc. Roy. Soc. A Vol. 122, 1929.

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Transients in Loud Speakers and Amplifiers.—

frequencies is directly proportional to the axial acceleration of the disc. But since the effective mass of the disc is constant the acceleration varies directly as the driving force on the disc. As this force is a copy of the electrical waveform of the transient so also is the acceleration, and therefore the acoustic pressure. Hence, under the conditions postulated in this discussion, the reproduction of a transient whose frequencies reside within the audible register would be perfect. In practice an observer situated on the axis of such an arrangement would himself cause distortion of the upper frequencies of the transient due to the presence of his body. The main effects involved would be diffraction and absorption of the sound. This, however, is beyond the purview of our present premises and will not be discussed. Nevertheless, it is well to bear in mind that the body of a listener does modify acoustic waveforms.

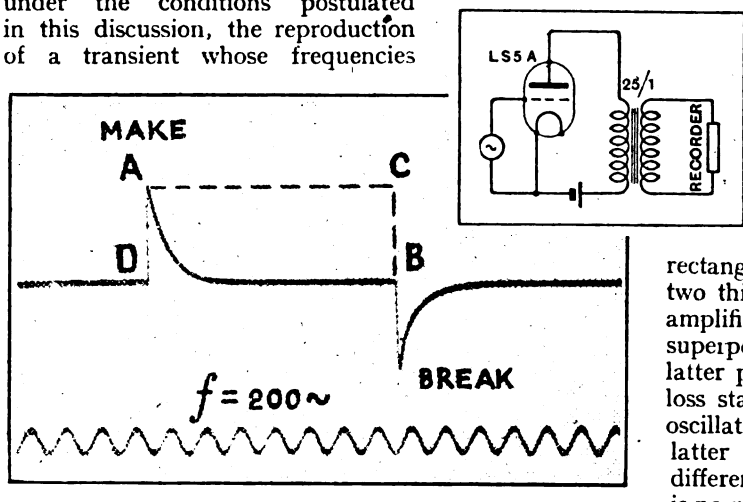

Fig. 6.—Record showing current in secondary of 25 to 1 transformer when rectangular waveform is applied to grid of valve. The primary is shown dotted at DACB.

Having seen from experimental records that, due to the superposition of their own natural oscillations, loud speakers do not reproduce severe transients with any degree of accuracy, we pass on to investigate the manner in which amplifiers behave in like circumstances.

How the Square-topped Waveform is Produced.

The reader is now familiar with the form of severe transient used for testing the loud speakers, this consisting merely of a series of Morse dots from the contacts of a special relay. The rise or fall of the voltage applied to the valve grid (see Fig. 3) is accomplished in a small fraction of a second, and corresponds acoustically to a sudden rise or fall in air pressure. In conducting experimental work on amplifiers this form of transient was used with results now to be set forth. To understand the effect of such a transient it is advisable to say a few words relating to the inner structure—so to speak—of the Morse dots. These dots occur fifteen times per second, and if we agree to regard them as an alternating current of rectangular waveform, its frequency is 15 cycles. Now this waveform can be considered to consist of a *sine* wave of 15 cycles accompanied by odd harmonics of 45 cycles, 75 cycles, 105 cycles, etc. The main or fundamental wave of 15 cycles determines the basic frequency of the dots, whilst the higher harmonics determine the sharpness with which the current starts and stops, *i.e.*, the squareness of the profile. Referring to Fig. 4, if we regard the time interval AB as one-quarter of a *sine* wave cycle it is clear that the smaller the value of AB the higher the frequency and the sharper the profile of the current wave. Moreover, the sharper the profile the more important are the higher frequency components. Thus, when a rectangular waveform of low basic frequency is applied to an amplifier, the resulting output is a measure of its capabilities of coping with a very wide frequency range, and at the same time of dealing with the impulses corresponding to make and break. A perfect amplifier would, of course, faithfully reproduce the rectangular waveform. A practical amplifier may do two things, (1) distort the waveform due to inadequate amplification of high or of low frequencies or of both; (2) superpose some natural oscillation of its own.[4] The latter phenomenon occurs, of course, in any H.F. low-loss stage and with most tuned anodes. If the natural oscillation has the same frequency as the carrier the latter is temporarily varied. If the frequencies are different a temporary beat will occur. However, there is no need to say anything further on the subject of H.F. amplifiers at the moment, and we will direct our attentions to the L.F. amplifier.

Transients and Various Intervalve Couplings.

In studying the problem of the rectangular waveform as applied to audio frequency amplifiers, it is convenient to treat various forms of intervalve coupling separately. The experimental arrangements will be indicated in each case. Starting off with an LS5A valve, in whose anode circuit the recording apparatus is directly situated, we proceed to key the grid, as shown in Fig. 5. The resulting waveform is illustrated in Fig. 5 and is substantially perfect. The auxiliary *sine* wave of 200 cycles shown on each record is for timing purposes. In the next case illustrated in Fig. 6 a 25/1 output transformer is interposed between the valve and the recorder. The only part recorded with accuracy is the initial rise of the current. At break where the current falls, its phase is altered 180°, *i.e.*, it is reversed. This case is worthy of further consideration. The valve can be represented by a resistance which at make suddenly decreases in value from ρ_1 to ρ_2, and at break increases from ρ_2 to ρ_1. In series with this variable resistance we have the primary of the transformer, as shown in Fig. 7. At make the primary current suddenly increases, thereby causing an increase in the magnetic flux and also a

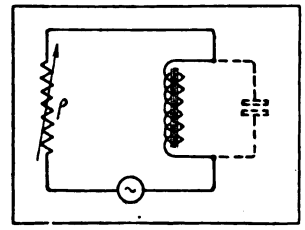

Fig. 7.—Equivalent circuit of valve and transformer. The valve can be regarded as a resistance which varies when the grid bias is altered. The self and mutual capacity effect of the transformer windings is shown dotted.

[4] The amplifier can also introduce harmonics due to non-linear amplification.

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voltage rise across the winding. But the secondary winding is on the same core, so that its voltage also rises and causes a current—whose waveform is shown in Fig. 6—to flow through the recorder. The current in the secondary rises rapidly to a maximum, but decays very quickly, so that there is no semblance of the rectangular waveform of the primary current. Now the initial rise is due to the high-frequency components, but the flat top of the wave is determined by the low-frequency components. In Fig. 6 the latter is conspicuous by its absence, and we naturally ask why? Every reader knows that the lower frequencies will only be reproduced if the primary of the transformer has an adequate inductance. In the present case the primary inductance was inadequate not only to reproduce 15 cycles but frequencies of higher value in the audible register. The reversal of current at break is due to the secondary current having fallen from A to B, whereas the primary current was steady from A to C. Thus when the primary is reduced at break the secondary current starts from B instead of from C. The acoustic effect would be identical in either case.

(*To be concluded.*)

AMENDING A RADIO ACT.

America's Reply to the British Radio-Cable Merger.

By A. H. MORSE, A.M.I.E.E.

IT is perhaps hardly correct to suggest that the huge American communications merger is a reply to the similar merger now being consummated in England; but colour is lent to the idea by the facts that the latter was first announced, and that it has been used as an argument in support of the former.

Begotten of a domestic market of unparalleled dimensions, the American's genius for industrial efficiency is, however, the sole cause and occasion for the extension of the merger idea to communications; and its conception probably long antedates that of the English scheme. It is merely a coincidence that the latter happens to furnish a powerful argument in favour of the removal of the only obstacle to the full consummation of the American proposal.

THE sole remaining obstacle to an alliance between wireless and cable interests in the United States is known as the White Act, a section of which prohibits the operation of radio and line communications under one administration, the object being to maintain competition in the public interest. In this article a New York correspondent shows how the Act may be circumvented, with results which may give America the most powerful communications unit in the world.

This obstacle, of course, is that section of the White Act which is intended to preclude the operation of radio and line communications by one administration, so that in the public interest the two means may be kept on a competitive basis. There is, however, a growing feeling that this lofty concept does not, and cannot, serve the desired end. In effect it is like restricting the operation of copper and iron conductors to separate and distinct companies. Only now is it coming to be generally recognised that the most dependable, cheap, and rapid communication service depends upon the availability of every means to each administration. In short, healthful competition must be looked for between systems rather than between means; and the general anti-trust laws must be relied upon to protect the public from unfair exploitation.

One of the parties to the present American merger has apparently met the requirements of the White Act by the simple expedient of forming a separate subsidiary; therefore, to the outsider, it seems that the present hesitancy in absorbing R.C.A. (Communications) is merely a polite gesture; and the exclusion from the merger of the Western Union system appears to be another. The historical, personal, technical, and geographical contracts between the Western Union and the prime movers of the pending merger are such as usually bespeak a community of interest, which is opposed to full competition.

In the circumstances, the present amendment of the White Act might bring about a parity between the communication conditions in England and America—wherein, incidentally, inventors and engineers had but one market for their inventions and brains; and such a prospect, while it lasts, may be taken to preclude any such amendment. But, in a typically American manner, there already looms a vast and entirely new communication organisation, which has given sufficiently satisfactory evidence that it is financially and technically competent to build and operate a nation-wide chain of short-wave, high-speed, public radio-telegraph stations. It is true that their licences do not permit them to engage in international communication, but they are now appealing against this unique disability, and there seems to be good reason why their appeal should succeed.

The Federal Radio Commission, which is charged with the difficult duty of administering radio in America, has very recently handed down a well-considered decision in the matter of an application of an organised and powerful section of the American Press, which has for years been operating a one-way (Westbound) European service via Halifax, N.S. This decision takes cognisance of the fact that applicants, however powerful and organised, represent but a section of the press; and concedes to the applicants some twenty trans-oceanic and twenty trans-continental channels upon—*inter alia*—the following conditions: Applicants must immediately incorporate (form a limited liability company) as a public utility; its stations must be located at points at other than premises controlled by any newspaper or press association; it must provide a bona fide public service open to all agencies of the American Press on a fair and equitable basis; and, in general, it must satisfy the Commission that its utilisation of its channels will serve public interest, convenience and necessity.

The Federal Radio Commission dies a natural death at the end of the current year. By that time its life may be again renewed, or the whole or a part of its functions may be taken over by a Communications Commission, which will administer all communications. In interested circles there is considerable agitation for and against the change; but it seems likely to come about, and there is little doubt that it will be timely.

WIRELESS AND MAGNETIC STORMS.

THE effect of magnetic storms on the strength of radio signals was the subject of an interesting announcement made at a recent meeting of the American Geophysical Union by Miss I. J Wymore, of the U.S. Bureau of Standards, and reported in the *Daily Science News Bulletin*, Washington, D.C. When the radio signals from European stations are weaker than usual and the signals from nearer stations in America are louder, it has been found that magnetic storms may be expected. After a magnetic storm much stronger signals are received from distant stations. The conclusions were deduced from the records obtained by experiments made with the long waves used for high-power transoceanic transmission.

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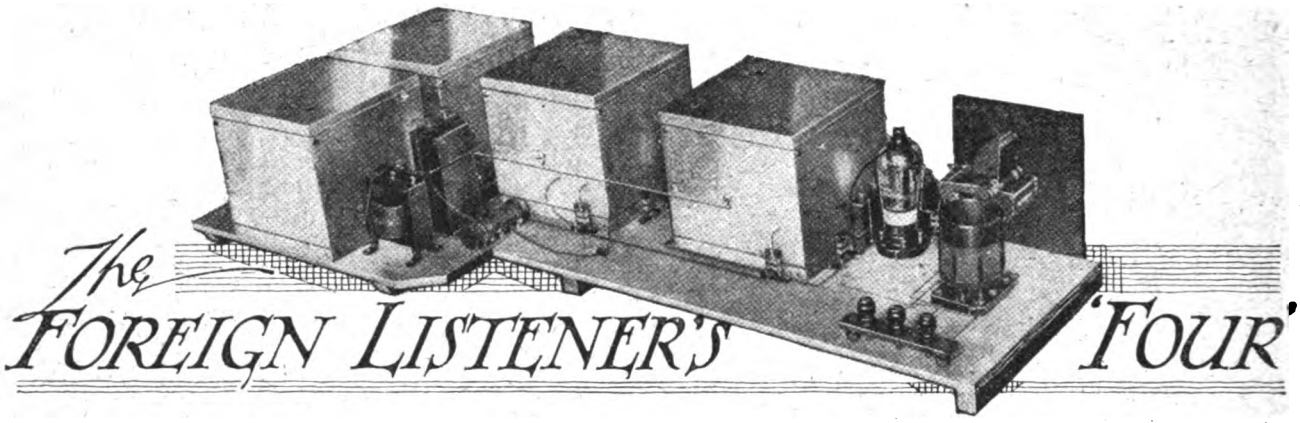


The FOREIGN LISTENER'S 'FOUR'

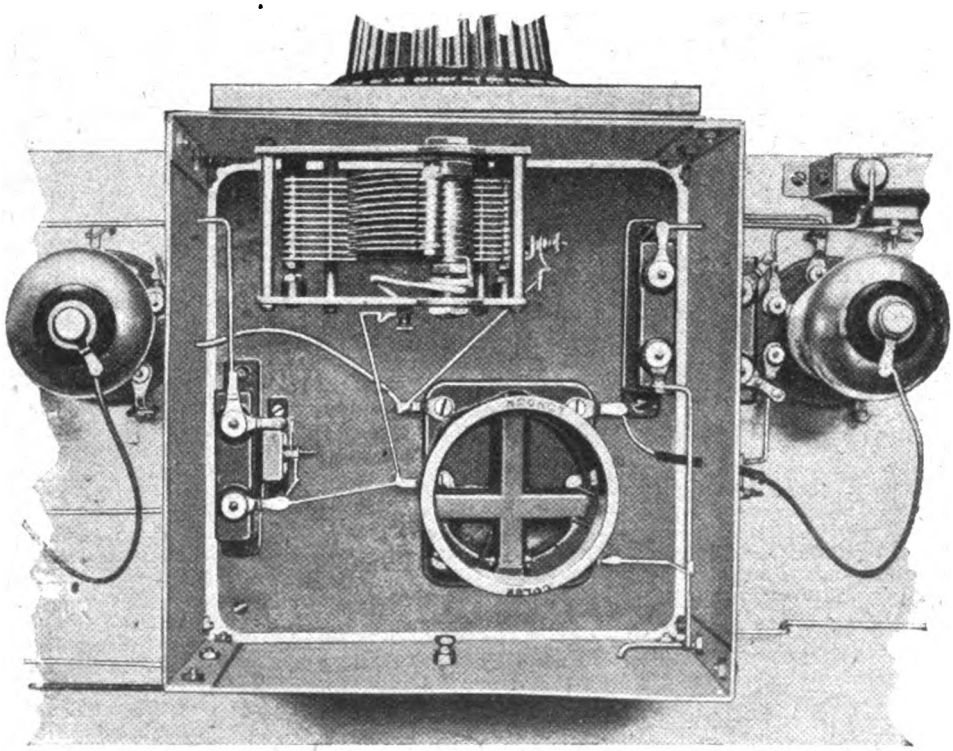
Constructional Details of the Long Range All A.C. Set.

By F. H. HAYNES.

(*Concluded from page 96 of previous issue.*)

A CONSIDERABLE saving is effected by building the eliminator as part of the receiver. By so doing much complication is avoided as compared with designing an eliminator which will suit all circuit arrangements. Windings on the mains transformer provide 5 volts for heating the filament of a U.5 rectifying valve, about 200+200 volts anode current supply, 4 volts for the three indirectly heated valves, and 5.5 volts for the P.625 output valve. All these potentials are obtained on the windings when the transformer is on full working load. Owing to the small load which is always maintained by the potentiometer the peak voltages from the eliminator are considerably reduced and the inexpensive low voltage condensers will not break down. Quite a small choke is used in conjunction with the condensers for smoothing, and although, in playing for safety, one might have specified more generous components, the smoothing apparatus does its work effectively.

As the current taken in the circuit feeding the screening grids is of varying and uncertain value, the potentiometer method of fixing this voltage is advisable, while H.F. interstage coupling is avoided with quite small resistances (600 ohms), combined with low capacity condensers (0.1 mfd.). To reduce the voltage to the leaky grid detector a series resistance is used which serves, at the same time, as a high impedance path to speech currents, and is thus a deterrent against L.F. oscillation. Little else need be said of this eliminator unit which involves few components, is wired up in a few minutes and cannot fail.



Screened interstage coupling following the first H.F. valve. Assembly and winding details are clearly shown.

It is believed that the particular form of baseboard construction adopted appeals to those who want results yet often consider it a waste of time to set up the workshop facilities necessary to make a well-finished set in an elaborate cabinet. Any reader desirous of making a cabinet enclosed set will not need

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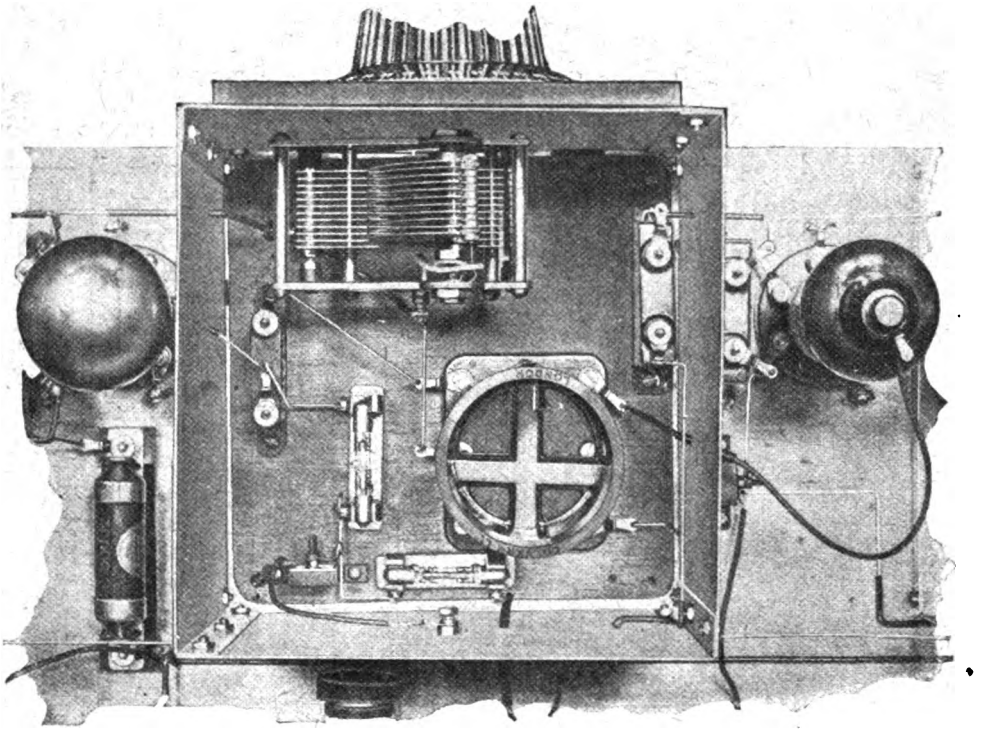
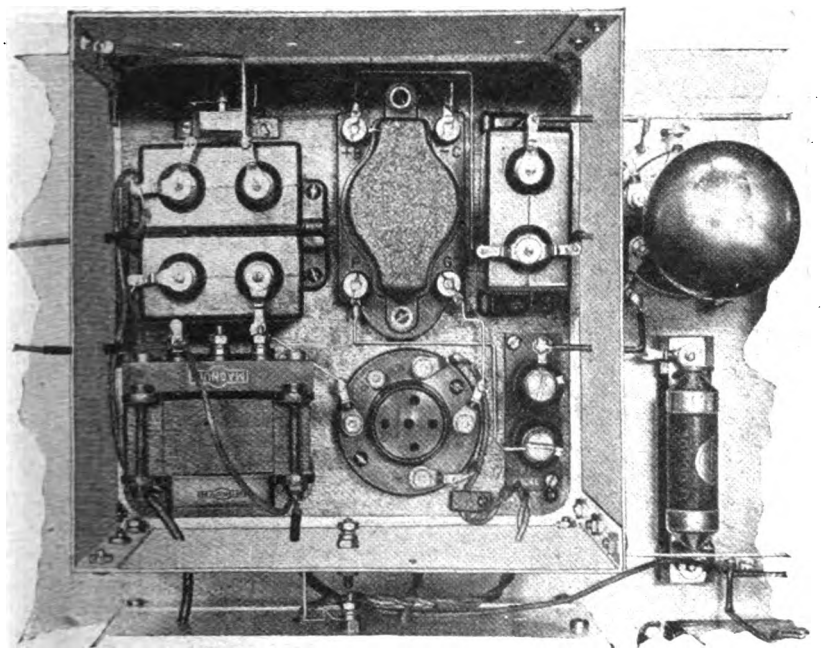
The Foreign Listener's 'Four.'—to be told here how to combine the three dials on to a single panel. In this connection two obvious modifications suggest themselves. First, a re-arrangement of the components whereby the detector valve and L.F. unit are placed behind the second H.F. stage, and the eliminator unit behind the first screening box. By this means a clean symmetrical panel layout of modest dimensions is produced. Ganging is the other modification, and although the writer prefers the unganged set, the linking of the two H.F. stages is permissible, as already mentioned. To do this use the appropriate condensers with extended spindles and arrange the H.F. stages one behind the other. Brackets will be needed to support the rear condenser panel while, as well as slightly modifying the wiring layout, it will be necessary to elevate one of the coil platforms so as to clear the spindle linking the two condensers. It is better, perhaps, to undertake this modification only after having followed out the working of the set with three dials.



The second screened unit. The condensers and resistances can be identified by reference to the practical wiring diagram.

Complete screening by means of spaced boxes ensures freedom from oscillation. Thus eddy currents set up in the screens are not common to the successive circuits. These separate boxes provide a double barrier against weak stray fields while, moreover, the electrodes of the valves themselves are protected from coupling with their associated circuits. Practice has shown this separation of the valves to be desirable.



Detector valve and the output unit. Note the closely twisted pair of leads carrying A.C. to the filament.

Practical Hints.

To give instructions as to the building of a set which merely comprises a baseboard assembly is, perhaps, scarcely worth while, but details of the procedure adopted by the writer may be helpful to follow. Clean down with fine glasspaper a good piece of planed board or plywood to serve as the base. If it is inclined to bend stiffen it with suitable battens. Taking dimensions from the plan view, the three A.C. valve holders may be located on the base and straightaway wired for A.C. supply, using twisted twin flex so as to minimise the A.C. field. Although it is better to use soldering tags the leads may, as an alternative, be well held down under screws, bearing in mind that a heavy current is to be passed and the fault caused by a high resistance contact will take a lot of finding. This pair of A.C. feed wires can be identified where they pass through the screen in

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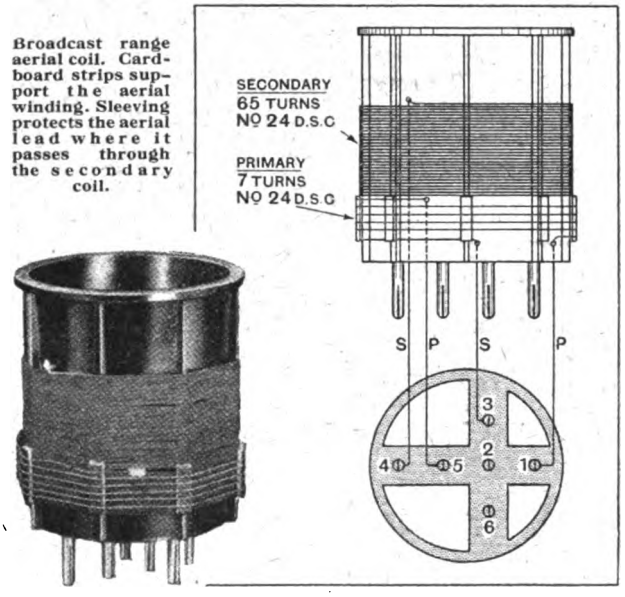
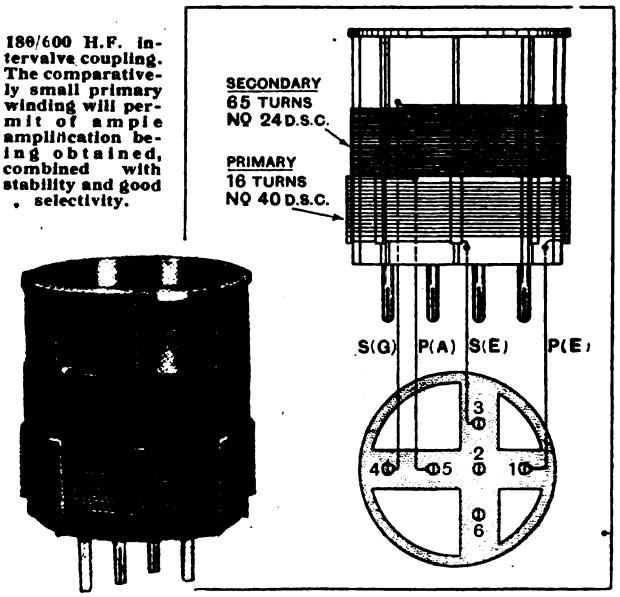
The Foreign Listener's 'Four.'—

the illustration showing the eliminator unit. Next in assembly, one should put down all other baseboard apparatus including the aerial tuning condenser.

Quite a lot of the wiring can now be carried out before any of the boxes are brought into position. Condensers and dials are fitted up in accordance with manufacturers' instructions and, if difficulties are to be avoided, one is cautioned when using the particular components specified to procure dials that will suit the condensers as mentioned in the list of parts. These particular dials are chosen for their convenience of operation. Note that the insulating panels overhang the lower edge of the screening box so that two or three screws can be driven through into the edge of the baseboard. Between the panel and the box a thin piece of cardboard is clamped so that the box will pull up securely to the panel in spite of the turnover of the aluminium at the bottom of the box and at the lid.



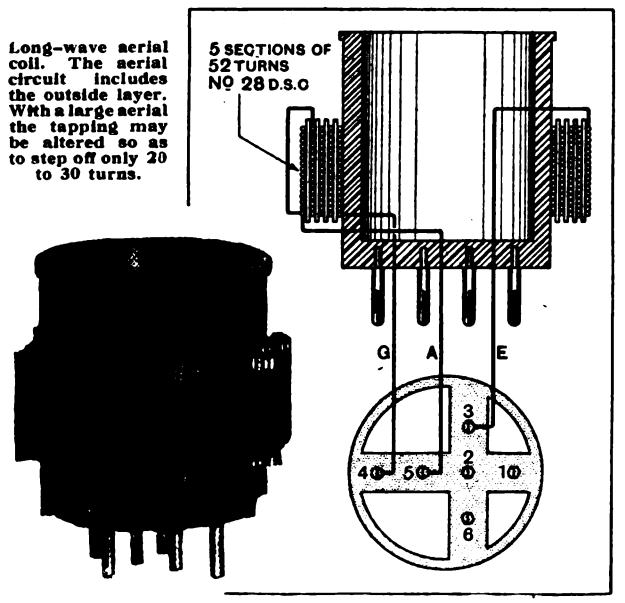
Broadcast range aerial coil. Cardboard strips support the aerial winding. Sleeving protects the aerial lead where it passes through the secondary coil.



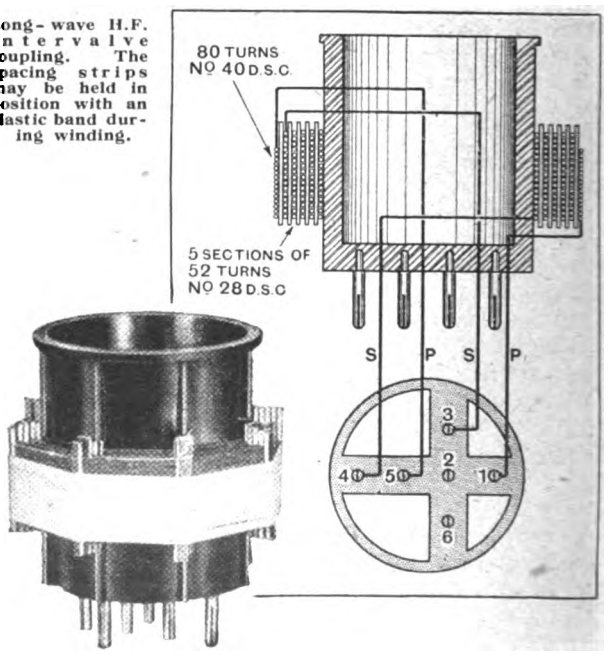
180/600 H.F. intervalve coupling. The comparatively small primary winding will permit of ample amplification being obtained, combined with stability and good selectivity.

It is the work of only a few minutes to attach the H.F. components to their respective baseboards procuring various round-headed brass screws for the purpose. A few leads can be run before dropping in the baseboards, but it is equally easy to solder them in position after screws have been passed through the bases and the boxes secured.

It will be appreciated that components have been



Long-wave aerial coil. The aerial circuit includes the outside layer. With a large aerial the tapping may be altered so as to step off only 20 to 30 turns.



Long-wave H.F. intervalve coupling. The spacing strips may be held in position with an elastic band during winding.

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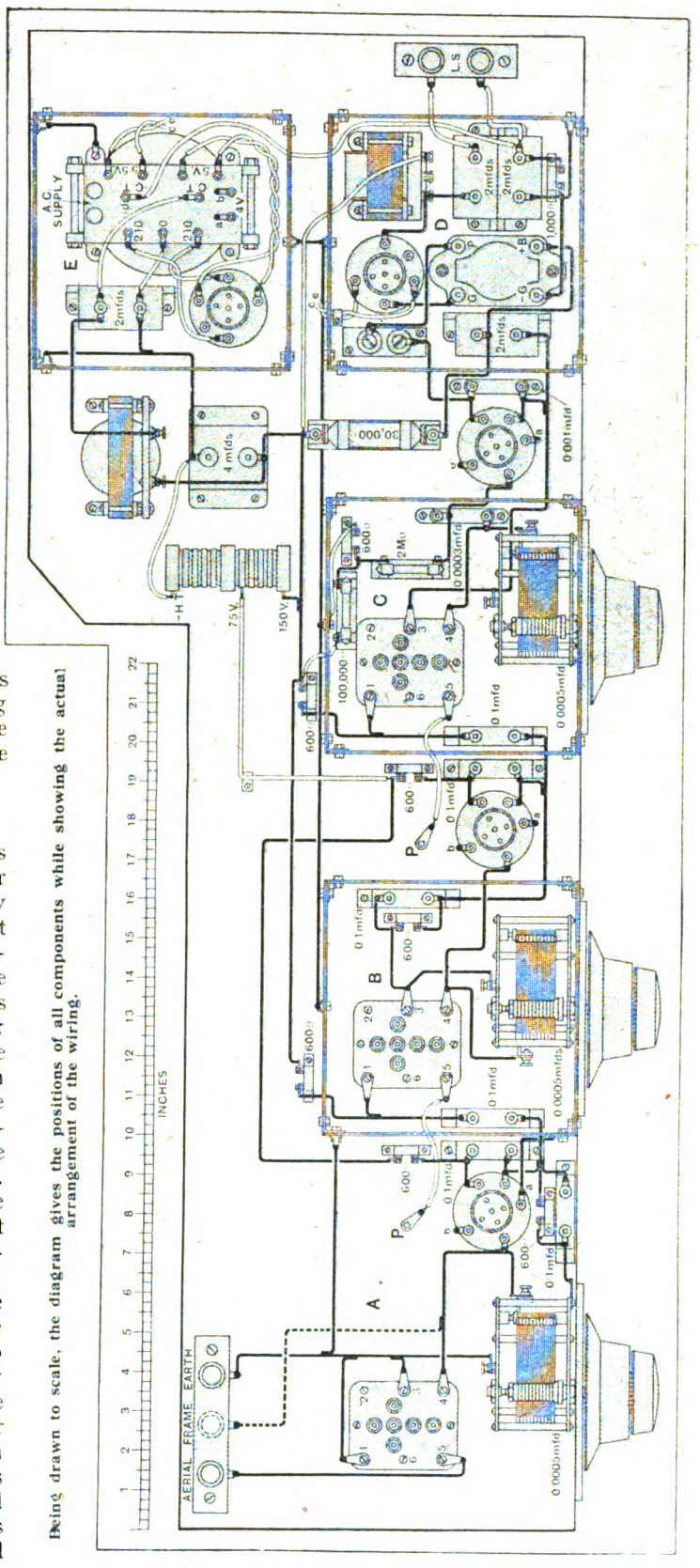
The Foreign Listener's 'Four.'—

selected which are all fitted with screw terminals so that, should one wish it, soldering can be almost entirely avoided. Short wires may be run anyhow between the points to be connected, and providing they do not stray too much the performance of this H.F. amplifier will remain unimpaired. Soldered stiff wiring and connecting tags, together with the use of sleeving wherever wires are near together or are required to pass through the screens, make an instrument in which the finding of faults is an easy matter. A flexible lead is brought out from each anode winding for the plate connection of the screened valves. It is advisable to additionally protect these leads with sleeving where they pass out through the screens. Much of the wiring in the L.F. stage can be completed before placing the baseboard into the box. Terminals are available on all components so that here, again, soldering can, if desired, be avoided. Use a twisted flex pair to carry the A.C. filament current of the output valve. Unlike the H.F. stages which pick up H.T.– through the condenser fixings a wire must be run in the case of the L.F. stage from the 1,000 ohm biasing resistance to the box, as can be seen in the illustration of this unit. No observations are necessary concerning the termination of the various wires on to the transformer in the eliminator unit other than the advisability of twisting all A.C. carrying pairs.

Heater Circuits Earthed

It will be noted that an earthing wire connects the A.C. heater circuit on the first valve holder to the nearest point on the screening box. By so doing the last traces of hum are removed, but in carrying this out it is desirable that the particular "side" of the A.C. shown should be earthed, while the corresponding heater terminals of the other two A.C. holders should be of similar polarity. A lead is shown earth-connecting the frame of the transformer, an optional precaution that, fortunately, makes no difference. In the practical wiring diagram the actual point of tapping the potentiometer is shown, although one might test for the position of best signal strength. Check and recheck the wiring before testing the set. It is so easy to omit a lead which, while not preventing the set from functioning, may considerably affect its behaviour.

Drawings and illustrations are given showing the construction of the coils. In every case the outside primary windings are in the opposite direction to the secondaries. By this it is meant that the low potential ends, which are, in every case, at the base, spiral off in opposite directions or, in other words, if the low potential ends were joined an inductive two-layer winding would result. Spacers are made from cardboard which has been soaked in shellac varnish and, when dry, cut into strips with a sharp knife. Coils for the broadcast band



Being drawn to scale, the diagram gives the positions of all components while showing the actual arrangement of the wiring.

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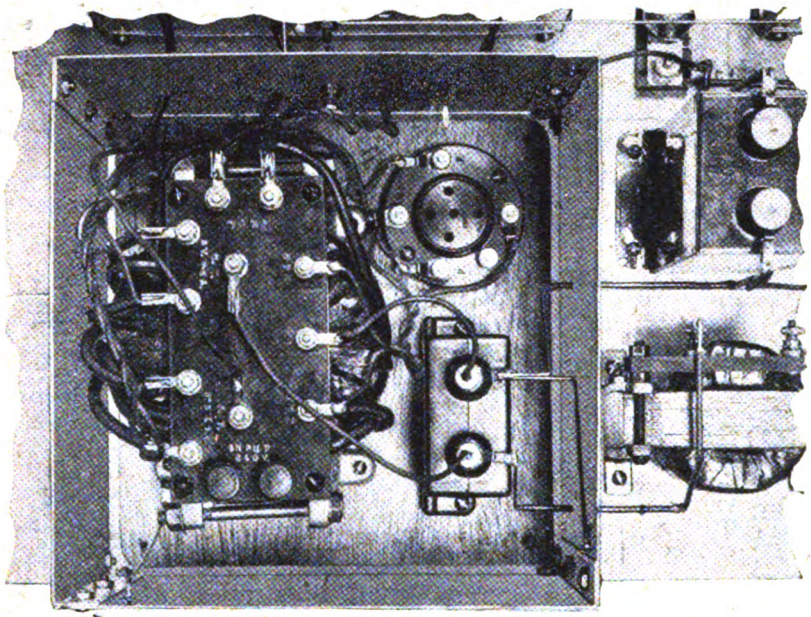
The Foreign Listener's 'Four.'—

are easy to wind, and for a single wave range set there is no objection to the use of shellacked cardboard formers 2¼in. in diameter and 2in. in length. Secondary windings should be elevated just clear of the surface of the former by a circle of cardboard strips. Where the top end of a primary passes through a gap forced in the secondary a piece of sleeving should be used to provide separation. When winding the long wave coils start each layer from the lower end by passing the wire across the turns.



The rectifier unit. Flexible leads are brought through the screen, adjusted to length and terminated on the transformer.

Although the windings given are intended to be definite, it is quite a simple matter to exceed the number of turns stated in respect of the primaries, taking off only just sufficient to give the desired selectivity. This is mentioned as it is obvious that conditions will vary with aerial dimensions and proximity to an interfering station. One cannot expect to adopt anything like the calculated number of primary turns for maximum amplification. A primary winding which will give stability with a single stage, neglecting for the moment aerial and detector damping, will need to be appreciably reduced when applied to a two-stage amplifier. Incidentally, it is the need for selectivity which brings down the primary windings far below the limits fixed for avoiding oscillation.

Use an elevated aerial with the set. It is better to adopt an efficient aerial with a small aerial winding than an improvised indoor one, although the latter will give good results. Tuning on the dials is not critical in that any one dial may be detuned by, perhaps, ten degrees without cutting out the station. If, however, two dials are turned one degree a loud distant station will disappear. Should either oscillation or loud A.C. hum be encountered, look for a wiring fault. When A.C. ripple becomes apparent on tuning in a station, and has the effect rather of modulating the carrier, it is safe to assume a faulty H.F. valve. Do not remove valves while the current is on as those valves remaining on the circuit may be injured by a rise in voltage. Although quite normal potentials exist in the set, one is recommended to always turn off the current before examining the circuit or, better still, before removing the lids. Volume control may be added if required by introducing a variable 30,000 ohm shunt across the primary of the L.F. transformer. Detuning is, however, satisfactory as a means of controlling strong signals. It is well worth recording for future reference station settings as they are obtained, many of the transmissions being easily identified by reference to wavelength programme data.

The Short-Wave Era.

Our readers may remember that in our issue of February 8th, 1928, we published a fairly comprehensive list of stations regularly transmitting on wavelengths below 100 metres. This list, compiled from information laboriously collected from several different sources, was copied in a number of foreign journals (sometimes with and sometimes without acknowledgment to *The Wireless World*), a fact that certainly gratified us as proving that our efforts were appreciated. Among the good resolutions made with the New Year one of the first was to revise and bring this list up to date, anticipating that it could probably be condensed within three or four pages of our journal. We deemed it advisable, however, to wait until call-signs and wavelengths had been adjusted to conform with the Washington Convention,

TRANSMITTERS' NOTES.

and, if possible, until the new "Berne List" had been issued, in order that the list might be as accurate as we could make it under the circumstances. The publication of the first part of the new "Berne List" and its supplements has, however, upset our estimate of the number of short-wave stations, for we find that out of over 2,800 commercial and Government land stations of which particulars are given, no fewer than 900 have short-wave transmitters, and many of these work on a number of different wavelengths—in some cases twenty or more. These do not include the stations performing special services, such as time-signals, weather reports and press messages, or broadcasting stations, of which the lists have not yet been issued by the International Telegraphic Bureau. It is obvious, therefore, that it is impracticable to publish a list that will be in any way comprehensive, within the limitations of our available space, and a selection is, as we know from experience, always unsatisfactory. We can, therefore, only advise those who wish for a complete list to follow our own example, procure copies of the "Berne Lists" and a copious supply of red ink with which to underline all the short-wave stations.

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A Correction.

Mr. H. A. Bartlett (G5QA) asks us to say that the address of his station is "The Laurels," 95, Old Tiverton Road, Exeter, and not that given, in error, in our issue of July 24th.

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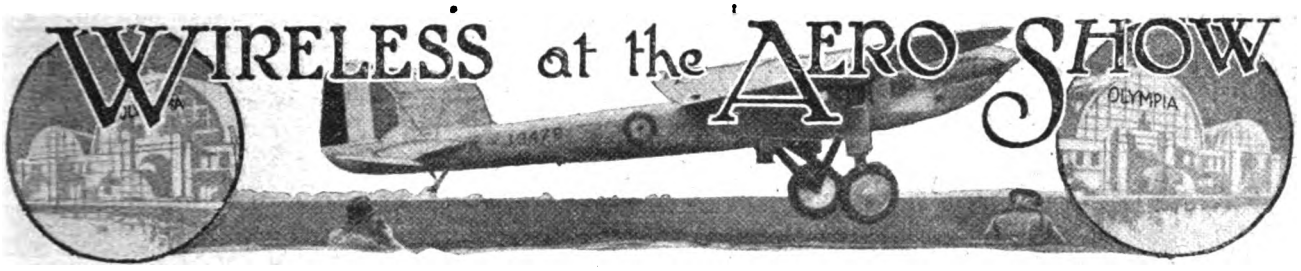
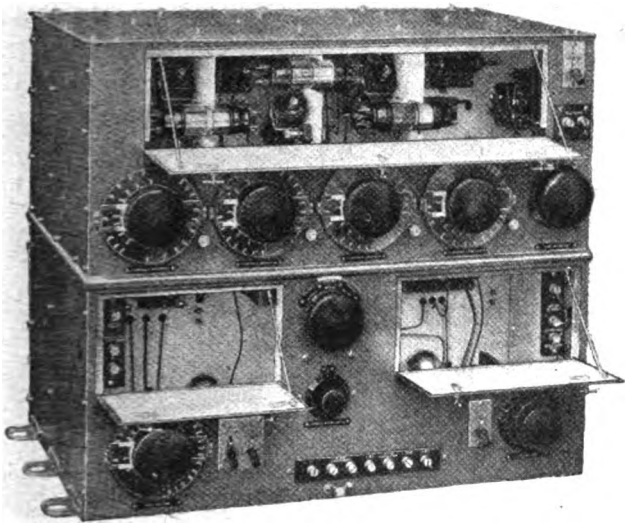


Descriptions of New Radio Apparatus for Aircraft.

IT is just conceivable that broadcasting, more or less as we know it to-day, might be carried out through a wire network; the Electrophone provided an illustration of possibilities in this direction. Similarly, our needs in the matter of rapid international communication are fairly well served by landlines and submarine cables without any supplementary radio channels. But those who travel by sea or air can exchange information



Three tuned H.F. stages with "10 per cent. ganging"; a Marconi direction-finder for ground stations.

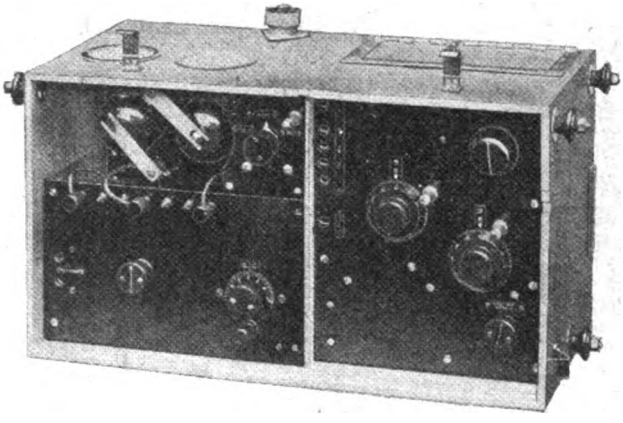
between themselves or with those on land in no other manner than by the wireless link; consequently, we find that the first important field of usefulness for radio telegraphy was in the navies and mercantile marines of the world. As soon as flying reached a state of development where it became possible to do something more than merely get into the air, experiments were made in transmission and reception; now an installation either for telephony or telegraphy is regarded as desirable—in many cases essential—for the majority of Service and civil aircraft.

Any possible reduction in weight and bulk is still of vital importance, and so we find that great ingenuity has been shown in the design of sets of almost incredible lightness and compactness. Stern economic pressure is partly responsible for this; the saving of each pound weight may well increase the earning capacity of a commercial aeroplane by a matter of shillings per trip. In this respect, designers of portable broadcast receivers might well have learnt some valuable lessons from an examination of some of the wireless apparatus shown at the recent Aero Exhibition at Olympia.

One of the most interesting and novel exhibits was the Marconi Type AD.22 telephony set for light aeroplanes. It is primarily intended for operation by the (wirelessly) unskilled owner-pilot, and is rated at 75 watts. It operates normally on wavelengths between 850 and 950 metres; in emergencies communication can be effected with shipping on 600 metres by throwing over a switch. The receiver is a fairly conventional arrangement of H.F. amplifier, reacting detector and one L.F. magnifier. Current is supplied by a combined H.T. and L.T. wind-driven generator, of which the output is sensibly unaffected by the air speed of the aeroplane; this is attained by an automatic governor controlling the windmill blade pitch. The set has a range of between 50 and 100 miles when working with a typical ground station, and weighs no more than some 60 lb. complete.

Marconi D.F. goniometer.

Short waves were used in early transmissions from aircraft, and it seems likely that increasing congestion on the 900-metre wavelength normally used for commer-



This Marconi "Light Aeroplane" transmitter and receiver weighs, with its generator, little more than the average transportable broadcast receiver.

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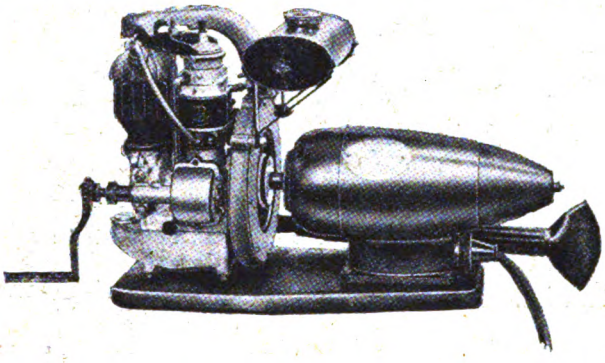
Wireless at the Aero Show.—

cial communication will be responsible for greater use of these high frequencies. They already have to carry a certain amount of naval and military aircraft traffic, and it is primarily for Service use that the Marconi

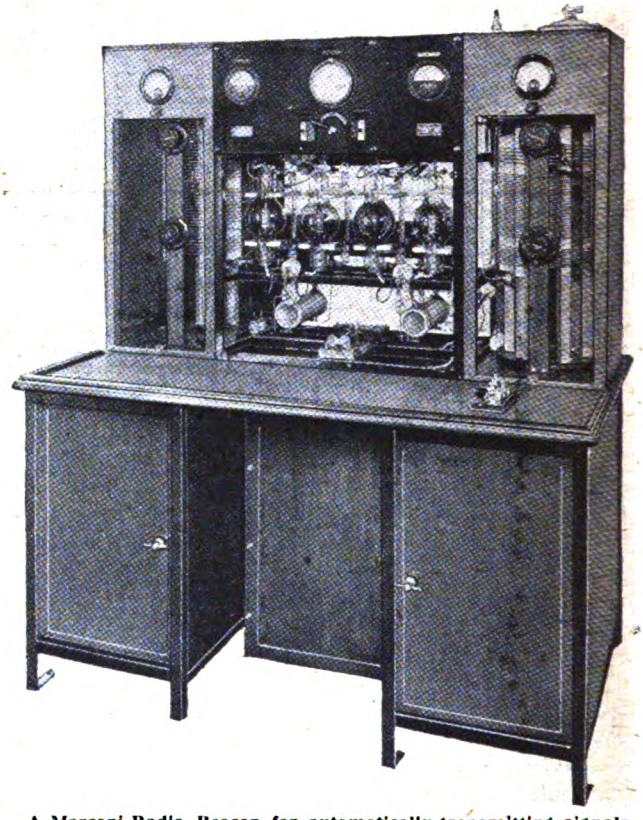


A lightweight petrol engine generating set for emergency use.

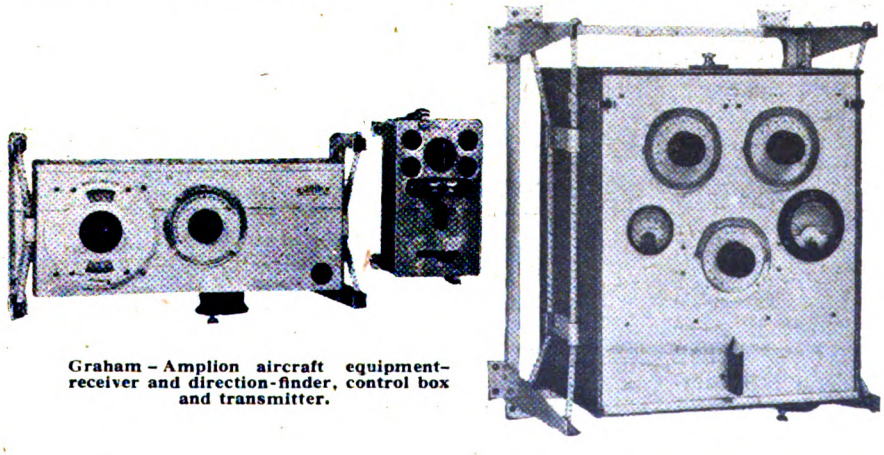
Type A.D.19 transmitter has been designed. This set operates on wavelengths between 40 and 60 metres, and functions either with a trailing or fixed aerial. Incidentally, one notices that the former kind of aerial is still widely used, although some of the large flying boats are fitted with a ship-type aerial stretched between a short mast above the leading edges of the main planes and the tail fin, so that communication may be maintained while on the water. For short-wave work the fixed aerial is to be preferred, although the transmitter in question is fitted with a drive oscillator for maintaining constant frequency. The power rating is 150 watts, and transmissions can be effected on telephony or C.W. telegraphy. In addition, a disc is fitted to the armature shaft so that interrupted continuous wave signals may be emitted. As in the case of the "light plane" set, anode and filament-heating current is supplied by a wind-driven generator.

The companion receiver (Type A.D.20) is an H.F. det.–L.F. three-valve combination. There is but one tuning control—that of the coupling circuit, the input from the aerial being aperiodic.

Space does not permit of a description of the many other Marconi aircraft sets, which are produced in types designed for almost all possible requirements. A ground station direction finder (Type D.F.M.4) was interesting, if only for the neat layout of its three tuned H.F. stages. Each grid and plate circuit is completely screened in separate compartments of the heavy metal case, while the feature of "ten per cent. ganging" is included. As most readers are aware, this arrangement has been included in several of the firm's receivers that have been described in these pages; individual tuning condensers are first set to a marked calibration nearest to the wavelength of the station whose signals it is desired to receive, after which searching may be carried out by rotation of a single knob which tunes all circuits simultaneously. The screen-grid high-frequency valves (Marconi S.625) are mounted horizontally, and project through the vertical partitions.



A Marconi Radio Beacon for automatically transmitting signals enabling aircraft or ships fitted with D.F. apparatus to find their bearings.



Graham-Amplion aircraft equipment—receiver and direction-finder, control box and transmitter.

Another product likely to interest the organisers of long flights over water is the emergency power plant. While all goes well, the ordinary windmill generator is perfectly adequate, but in the event of a forced descent it becomes useless—at a time when the ability to use the wireless installation is particularly vital. For emergencies of this kind, a small 1 h.p. two-stroke petrol motor has been de-

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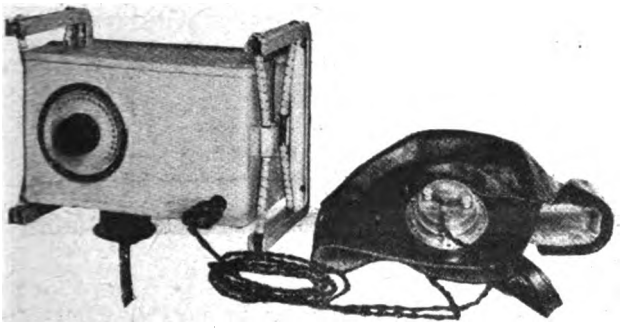
Wireless at the Aero Show.—

signed; it is air-cooled, and, with a bed-plate to accommodate it and a generator, weighs about 30 lb.

It was noticed with interest that the well-known firm of Graham-Amplion, Ltd., in conjunction with its parent company, have entered the aircraft wireless field, and have produced a range of apparatus of unusual design. The most ambitious outfit shown is an air port equipment of which the nucleus is a ½ k.W. transmitter for telephony, telegraphy, and I.C.W. Receivers for normal or medium wavelengths are supplied, together with direction-finding equipment and extra amplifiers. A unit system is employed, and so any desired combination can readily be assembled.

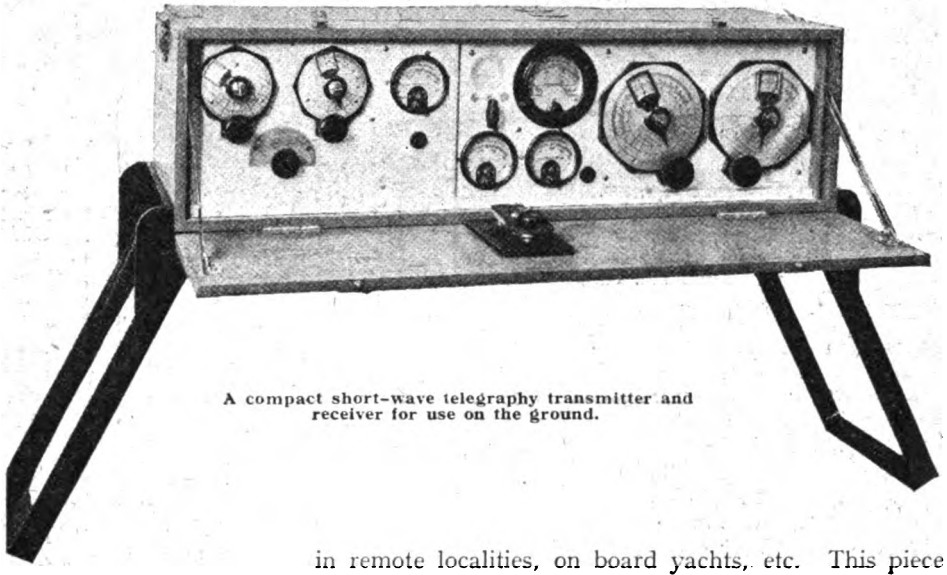
The Amplion aircraft set, type G.A.1, comprises a transmitter, control box, and receiver with direction finder. There are, of course, the usual accessories, such as generator and aerial reel, etc. The main units are suspended in a skeleton frame by means of heavy rubber cords which act as shock absorbers. A similar outfit, Type G.A.2, is of the same appearance, but does not include direction-finding apparatus, the space in the left-hand side of the receiver case being used to house an oscillator (for C.W. reception).

Most of the Amplion receivers are of similar design, and comprise two aperiodic H.F. stages, the transformers of which are designed to peak at 900 metres. Screen-grid valves are used, and space is saved by mounting the coupling device directly on the anode terminals in the manner shown in an accompanying illustration. Spring clips mounted inside screening tubes, which are secured to the underside of the lid, are arranged to grip the bulb of the valve, and thus to avoid risk of damage. At the same time adequate interstage screening is provided by this method of construction.



An Amplion four-valve receiver for the owner-pilot, weighing only 3½ lbs.

Although not intended for use in aircraft or, indeed, for communication with them, the Amplion "short-wave intercommunication" set is worthy of mention. It was designed originally for ground work by aerial survey expeditions, but is equally applicable for use in remote localities, on board yachts, etc. This piece of apparatus comprises a short wave telegraphy transmitter and receiver mounted in a compact case with folding metal legs. It derives all its energy from a generator run from a 12-volt alkali accumulator battery, which, in cases where no other source of electrical power is available, may be charged by means of a dynamo operated by man-power through pedals and gearing.



A compact short-wave telegraphy transmitter and receiver for use on the ground.

Economical of weight and space: Amplion method of mounting "aperiodic" H.F. transformer on the anode terminal of an S.G. valve.

Announcements to the public in the hall at Olympia were made through a battery of Amplion loud speakers—including two of a new pattern. This instrument embodies a long coiled logarithmic horn, housed in a wooden box, and actuated by a moving coil drive unit. The combined effect of these loud speakers, in conjunction with two of the "Lion" type, struck the writer as being exceptionally good.

A full range of electrical measuring instruments was shown by Ernest Turner, of High Wycombe. Practically all the requirements of the wireless user are catered for by the products of this firm. In particular it was noted that small panel-mounting milliameters with several ranges intermediate between 0-0.5 milliamp and 0-2.5 milliamps are standard productions. These should be of interest to those who are adopting the practice of inserting a meter in the anode circuit of a bottom bend detector.

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THE COMPLEAT CADET.

Instruction in Morse signalling and wireless forms part of the programme which is being carried out by the Public Secondary Schools Cadets now encamped on Marlborough Common.

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ANOTHER PARIS WIRELESS SHOW.

A wireless section is to be included in the *Concours Lépine*, or Small Inventors' and Manufacturers' Show, to be held in Paris at the Parc des Expositions, Porte de Versailles, from August 22nd to September 30th.

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GERMAN LICENCE DECLINE.

At the end of June the number of receiving licences current in Germany amounted to 2,826,628, showing a decrease of 11,266, as compared with the figure at the end of March.

The British licence "curve" has shown a temporary drop on three occasions, viz., October, 1924; July, 1925, and October, 1926.

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SPANIARDS MUST PAY.

Under a new decree, Spanish listeners must now pay a quarterly tax on their receivers. The crystal user is treated very generously, his quarterly fee amounting to only one peseta (8d.), whereas valve owners must pay five pesetas.

Transmitters pay an *ad valorem* tax of five per cent.

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WIRELESS FOR ANTARCTIC EXPLORERS.

The barque *Discovery*, which left the Thames on August 1st for a new voyage of Antarctic exploration, is equipped with Marconi wireless apparatus that should enable it to maintain constant communication with the outside world. The expedition, which is under the leadership of Sir Douglas Mawson, the famous Australian explorer, has been specially equipped for scientific and survey work in the Antarctic to the south of Australia.

In addition to a Marconi 1½ kilowatt quenched spark transmitter and a ship's receiver, a Marconi short-wave telegraph transmitter is to be used for communication with Australia and Great Britain from the heart of the Antarctic. In conjunction with this transmitter a new Marconi short-wave receiver is fitted.

A wireless direction finder also forms part of the navigational equipment, while the Moth aeroplane to be carried by the expedition is also being equipped with Marconi apparatus. The aeroplane is to be used for scouting purposes within a range of 100 miles of the *Discovery*, and it is being fitted with the new Marconi transmitting and receiving set for light aeroplanes, recently described in these columns.

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HOLLAND'S OUTPUT OF RADIO GEAR.

According to the *Algemeen Handelsblad* the total export from Holland of wireless goods during 1928 has been exceeded by about nine million florins during the first five months of 1929.

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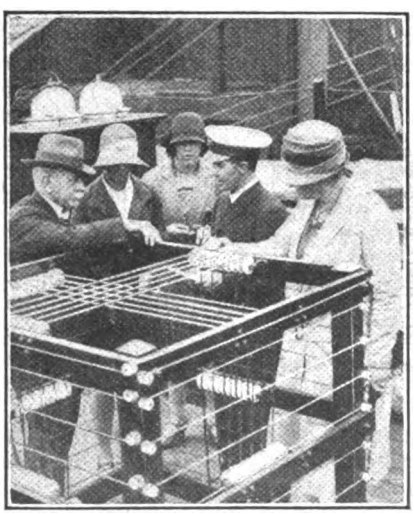
TONIC TALKS FOR THE TRADE.

If Dr. Julius Klein, U.S. Assistant Secretary of Commerce, is correct in his estimate, the wireless business has a glorious future. On the basis of five listeners to every set, Dr. Klein sees a potential world market for 200,000,000 radio receivers. A recent survey by the Department of Commerce showed that there are about twenty million sets already in use, two-thirds of this number being in the United States.

Lest the radio trade should grow despondent at the prospect of reaching saturation point, it should be noted that Dr. Klein has not allowed for wear and tear of existing sets.



D.F. ON "DISCOVERY." The wireless operator on Sir Douglas Mawson's Antarctic exploration ship in the East India Dock explains the functions of the frame aerial.

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JAMAICA TO BROADCAST.

Proposals for the establishment of a broadcasting station are announced by the Government of Jamaica. It is prescribed that the company to which the concession will be given must be incorporated in the colony.

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I.B.C. ATTACKS INDIAN PRESS.

The Indian Broadcasting Company celebrated its second birthday on July 23rd. In a leading article in the *Indian Radio Times*, the company deplores the indifference to broadcasting shown by the Indian newspapers, which are stated to have ignored the "pirate" problem—the main obstacle to the success of Indian broadcasting—by withholding reports of questions in the Legislative Assembly and Government replies thereto on the subject of illicit listening and the steps to be taken to enforce the law. The company calls for "a real live increase in the number of licences."

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ONE OF THE FLOURISHING TRADES.

In his report for 1928, just published, Sir Gerald Bellhouse, Chief Inspector of Factories, states that whereas business was bad in such industries as cotton, iron and steel, and shipbuilding, there was a decided briskness in electrical equipment, wireless, and gramophones. The flourishing trades were well represented in the south.

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PROGRAMMES FROM CHINA SOON?

By January, 1930, China is expected to enter the field of international wireless with the opening of two short-wave stations for communication with the United States. During a recent visit to the headquarters of the American National Broadcasting Co., Dr. Cha Tsao, a member of the radio mission of the Chinese Reconstruction Council, stated that a national system of broadcasting was also being contemplated and that it would probably follow the American system, revenue being obtained from advertisements.

Nearly one hundred young men in China are studying to become radio engineers, and on them will fall the responsibility of establishing China's broadcasting chain.

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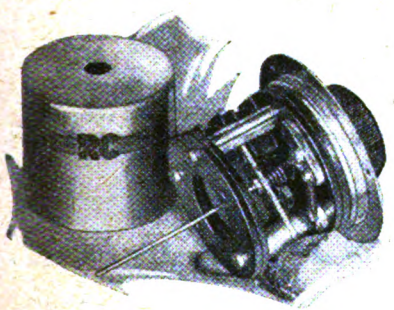
NEW APPARATUS

A Review of the Latest Products of the Manufacturers.

"R C." CONE LOUD SPEAKER UNIT.

This unit consists of two permanent magnets and two laminated pole pieces carrying the coils. The vibrating reed is mounted centrally between the pole pieces and is fixed rigidly at one end. Attached to the mid-point of the reed is a strong helical spring, the tension of which is controlled by a large adjusting screw. This enables the air-gap between the reed and the pole pieces to be fixed to suit conditions. The spindle carrying the cone is mounted at right angles to the reed and protrudes approximately 2in. beyond the metal case which encloses the unit.



"R.C." cone loud speaker unit with cover removed.

These movements are supplied by the Ridged Cone Co., Ltd., York House, Theobalds Road, London, W.C., and the price is 13s. 6d.

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WATMEL FIXED CONDENSERS.

Tin foil is used for the plates and mica forms the dielectric in the Watmel fixed condensers. These are enclosed in a neat moulding with the terminals on top. In certain cases clips are provided for a grid leak, but, since separate terminals are fitted, the connections necessary for the particular requirements of the circuit, in which they are used, can be made externally. The combined leak and condenser is compact and takes up very little baseboard space.

Some samples sent in for test were measured and the capacities were found to be within 10 per cent. of the marked values.

Rated Capacity.	Measured Capacity.	Percentage Error.
0.0001 mfd.	0.00009 md.	−10%
0.002 „	0.0022 „	+10%

Watmel fixed condensers. Capacities up to 0.0009 mfd. are fitted with grid leak clips.

The makers are the Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware, Middlesex, and the prices have been fixed as follows: 0.00004 mfd. to 0.0009 mfd., fitted with grid leak clips, 1s. 6d. each; 0.001 mfd. to 0.004 mfd., without clips, 1s. 9d. each; and other values up to 0.01 mfd., 2s. 6d. each. Grid leaks cost 1s. each for values from 0.25 to 5 megohms.

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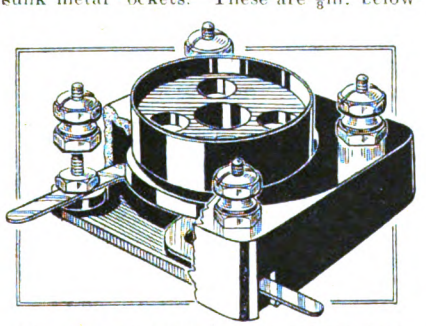
"FORMO" VALVE HOLDER.

The "Formo" anti-microphonic valve holder is compact, neat, and inexpensive; it costs 1s. 3d. only. Soldering tags as well as terminals are provided, but its main feature of interest is, perhaps, the sunk metal sockets. These are ⅛in. below



Formo valve holder. The spring and soldering lug are in one piece.

the top of the bakelite centre, and it is impossible to make contact with the pins on the valve unless they are correctly aligned with the sockets. Danger of burning out the valve due to mal-alignment is non-existent.

Stout phosphor-bronze springs are riveted to the brass insets, and these form also the soldering tags. The terminals pass through holes in these lugs, and are held in contact by means of small nuts inside the shell. When connecting wires to the terminals, care should be taken in tightening the hexagonal terminals, since excessive force may loosen the screw and lead to the inside nut becoming loose and thereby leading to an intermittent contact. Apart from this small matter, the general design is sound, and the valve holder can be confidently recommended.

The makers are the Formo Co. (Arthur Preen and Co., Ltd.), Crown Works, Cricklewood Lane, London, N.W.2.

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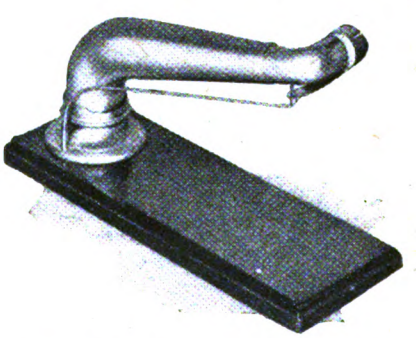
"D.X." AUTO-TRACK TONE ARM.

The new "D.X." tone arm, which is particularly suitable also as a pick-up carrier, has been designed to ensure that the



New "D.X." tone arm showing self-aligning device to reduce wear on the record.

needle maintains correct alignment with the grooves in the record during the whole of its travel. The pick-up holder is pivoted to the arm and its angle, with relation to the arm, controlled by a lever attached to a radial spring, which can be seen in the illustration.

The movement of the needle is thus more in the nature of a radius than an arc, and it is claimed that this feature reduces record wear and prolongs the life of the discs. This useful accessory is supplied by Messrs. D.X. Coils, Ltd., 542, Kingsland Road, London, E.8, and the price has been fixed at 10s. 6d.

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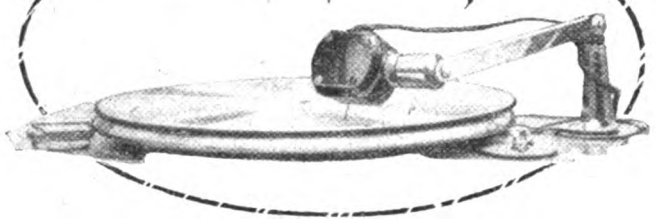
Mounting the Gramophone Pick-up

Simple Instructions for



Obtaining Correct Alignment.

NOW that a large number of sets are adapted for the electrical reproduction of gramophone records in addition to their regular duties, there is a growing interest in the design of pick-ups and their mountings. In particular, attention has recently been drawn to the question of accurate tracking of the needle with respect to the record and to the fallacy that the ideal position of the tone arm is such that the needle passes over a point at the centre of the turntable. The writer recently tackled the problem from a mathematical point of view, and the following results were arrived at:—

1. If an ordinary tone arm is correctly placed and the pick-up is properly adjusted thereon, the tracking can be made to approach very nearly to the ideal without the inclusion of special devices for ensuring a straight-line motion or its equivalent.

2. The track of the needle should not pass through the centre of the turntable.

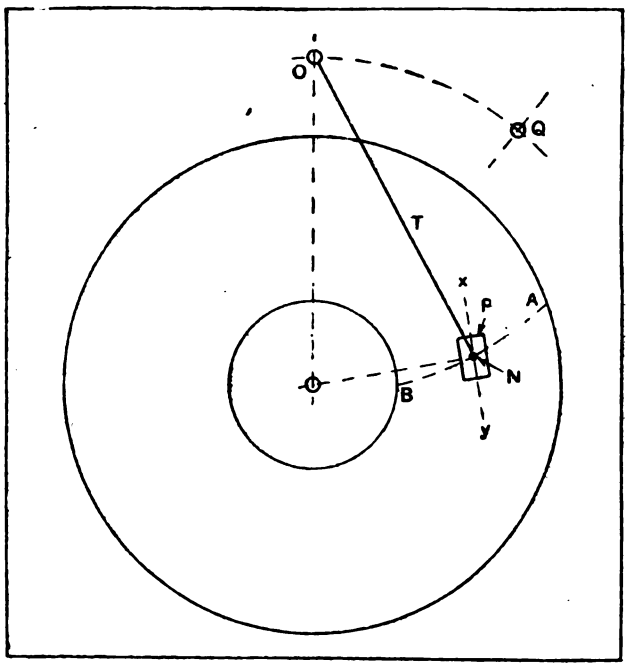


Fig. 1.—The relative disposition of the tone arm T, the pick-up P, and the needle N, can be easily seen in this diagram.

3. A simple formula for calculating the best position for a tone arm of any length may be evolved.

It is well known that to obtain the best reproduction, coupled with minimum wear on the record, the needle should lie in a plane tangential to the record groove at the point of contact and should be free to move at right angles to the groove. Thus, in Fig. 1, if N is the needle of a pick-up P resting in the position shown, and the needle is free to move across the record, the movement is at right angles to the tangent *xy* at the point of contact.

The Variables Concerned.

Clearly, if the needle is mounted on an ordinary tone arm T, moving, say, about a centre O, the needle must move along a curve AB, and cannot be correctly placed with regard to the record at all points in its travel. With an incorrectly placed tone arm the error may be considerable. Our problem, then, is to find the position of the tone arm which gives the minimum error.

The variables concerned are:—

(*a*) The length of the tone arm.

(*b*) The distance of the pivot from the centre of the turntable.

(*c*) The angle which the pick-up makes with the tone arm.

(*d*) The dimensions of the record itself.

It should be noted that the disposition of the tone arm in relation to the gramophone itself is immaterial. Thus, in Fig. 1, it does not matter whether the arm is pivoted at the point O at the centre back of the cabinet, or at a point Q at the back right-hand corner, so long as the distance from the pivot to the centre of the turntable remains the same. It is sufficient, therefore, to arrive at the ideal value for this distance, and then to fix the tone arm accordingly in any part of the cabinet that is convenient.

Fig. 2 illustrates the method of arriving at the correct position for the tone arm pivot. The arm *c*, of length BA, is pivoted at B, and in playing the record the needle moves from a point A at the outside of the playing area to a point A_1 at the inside. The actual shape of the arm does not concern us and for our present purpose the most elaborately shaped arm could be replaced by a straight rigid rod extending from the pivot to the needle.

For perfect tracking, the line of the pick-up (that is,

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Mounting the Gramophone Pick-up.—

the plane of the needle) must always be tangential to the groove, or, what is the same thing, at right angles to the radius *b* drawn from the centre C of the turntable to the point of contact A. Since the angle between the arm and the pick-up is fixed, this condition can be maintained only if the angle between the arm and the radius is constant. Unfortunately, this angle must vary as the needle passes from position A to position A_1. It is possible, however, to arrange that the angle, and therefore the tracking error, is equal at the inside and outside of the playing area. The error can then be spread over the entire path of the needle so that it is never more than a small amount.

Calculating Tone Arm Length.

The formula by which we may readily determine the correct distance from the tone arm pivot to the turntable centre is $a = \sqrt{c^2 - 12}$*, where *a* is the distance from the pivot B to the centre C, and *c* is length of the tone arm. To find the required distance, therefore, we must square the length of the tone arm from pivot to needle, subtract 12, and find the square root of the result.

This distance having been found, it still remains to fix the pick-up at the correct angle to the tone arm. If we decided to fix the angle so that there was no error at the inside and outside, we could calculate the value of cos A from the triangle formula. Reference to trigonometrical tables would then give the value of the angle A, and it is obvious from the diagram that the angle between the pick-up and tone arm is equal to 90° − A. But if this were done, the error at a point midway between the inside and outside would be greater than it need be. A better method is to fix the angle so that there is no error at a point, say, one inch from the outside, that is, at a distance of 5in. from the centre. There will then be an error in one direction at the outside, falling to zero when the needle has moved an inch towards the centre, then rising to an approximately similar error in the opposite direction, falling to zero again and finally rising to an error equal to that at starting as the needle reaches the end of the track.

The value of cos A for a radius of 5in. can be found at once by substituting that value for *b* in the triangle formula, all the other values now being known. The angle can then be found from the tables and subtracted from 90° to find the angle at which to place the pick-up.

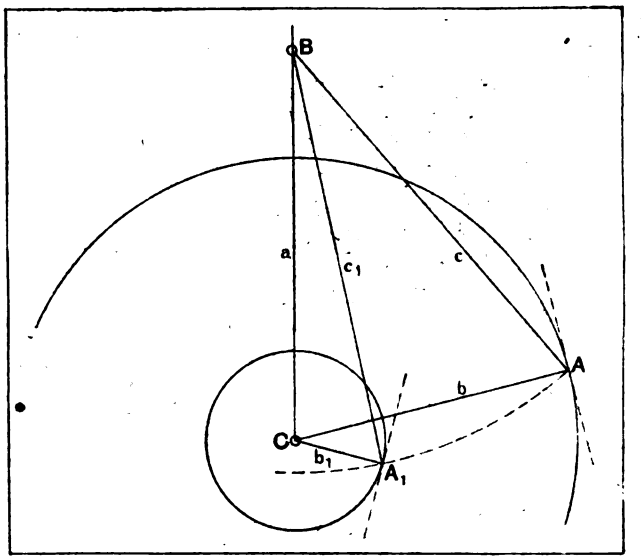

Fig. 2.—Method of finding correct position for tone arm pivot.

As a matter of fact, it is an easy matter in practice to adjust the pick-up by eye so that the plane of the needle is tangential to the track at a radius of 5in. In all cases the angle is appreciable, and it is absolutely essential that the arm should be provided with means for its adjustment.

If the above principles are followed, it will be found that for a tone arm of ordinary length the maximum departure from tangential tracking can be kept below 2°. This is much less than can be attained by rule-of-thumb methods, and is quite low enough to ensure good reproduction and long record life.

In brief, and by way of summary, one should first determine the distance BC, Fig. 2. To do this, square the length of the tone arm as measured between pivot and needle, subtract 12, and take the square root of the result. Making use of the distance thus found move the position of B until the needle points in the direction of a tangent to the groove when at a point about 5in. from the centre spindle. Should the pick-up possess the desirable feature of permitting of adjustment on the end of the arm, then the precise location of B is immaterial so long as the distance BC is maintained, and in these circumstances the pick-up will need to be swivelled to the tangential position when the needle is 5in. from the centre.

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* If, in addition to the lettering already adopted, we denote the angle between the arm and the radius by A, and the distance from the pivot B to the centre C of the turntable by *a*, then, according to the usual formula for the solution of triangles,

$$a^2 = b^2 + c^2 - 2bc \cdot \cos A$$

$$\therefore \quad \cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

The inside radius of a twelve-inch record may be taken as 2 inches and the outside radius as 6 inches. Therefore, for the outside,

$$\cos A = \frac{6^2 + c^2 - a^2}{2 \times 6c} = \frac{36 + c^2 - a^2}{12c}$$

and for the inside,

$$\cos A = \frac{2^2 + c^2 - a^2}{2 \times 2c} = \frac{4 + c^2 - a^2}{4c}$$

But if the angle A is equal at the inside and outside, the above expressions must be equal:

$$\frac{36 + c^2 - a^2}{12c} = \frac{4 + c^2 - a^2}{4c}$$

Therefore

$$36 + c^2 - a^2 = 12 + 3c^2 - 3a^2$$

$$2a^2 = 2c^2 - 24$$

$$a = \sqrt{c^2 - 12}$$

If the formula is worked out in full, without assuming any particular size of record, it becomes

$$a = \sqrt{c^2 - r_1 r_2}$$

where r_1 and r_2 are the inside and outside radii respectively.

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THERE ARE MORE THINGS IN AERIALS AND EARTHS

O Radio, Than are Dreamed Of in *Your* Philosophy.

By D'ORSAY BELL, M.A.

THE kind reception given to my first article, on various parts of the frequency spectrum, shows that the readers of *The Wireless World* are ready to take a keen interest in new work on lines akin to "Radio" proper, but not directly connected with it. Now, of the vast amount of research and invention going on these days over all the world quite an important fraction is of this kind, and the Editor has given me the pleasant job of keeping his large circle of readers informed, from time to time, of recent results in these fields.

Anything will be grist for my mill so long as it concerns wave-motion of some kind. It may be something of immediate, practical importance, or it may be—at first sight, anyhow—a purely high-brow contribution to the sum-total of our knowledge. I say "at first sight" because sometimes, before it knows where it is, one of these high-brow items of knowledge is seized upon and dragged protestingly into the most commercial developments—look at the Dewar cup and its metamorphosis into the "Thermos." But enough of introductions—there is so much to write about and time is so short. . . .

In my first article I mentioned that Lakhovsky had cured his begonias of an (ordinarily) fatal disease by surrounding them with an open spiral of wire, insulated from everything and—as he thought—picking up the cosmic rays and thus surrounding the sick plant with weak oscillations of a frequency of about 10^{22}. The curative effect of these open spirals has since then been tried on human beings: several doctors who have tested this treatment have reported good results. I think a sweet picture could be made of one of Tom Webster's bookmakers being cured of cigar-shaped fungoid growths, with his head peeping like a wistful flower above spiral-formed foliage. But I am afraid we cannot attribute the healing effect of these spirals to cosmic rays as was first thought; the idea now is that the spirals pick up all kinds of impulses from the air—broadcast messages, spark disturbances from motor-cars, and so on—and convert them into weak oscillations of the natural wavelength of the spirals themselves: varying from a third of a metre to two metres. This region of the frequency spectrum is quite fascinating.

"At first sight a purely high-brow contribution to the sum-total of knowledge."

The "Ultra-shorts."

Anything under 10 metres, among wireless waves, comes into this category. From a medical point of view the most interesting are the waves below 5 metres. Long before Lakhovsky and his spirals D'Arsonval had used these radiations for their medical effects, and recently a new development in "D'Arsonvalisation" (as it is called) has enabled certain drugs to be carried through the skin and body-wall to the particular organs which need them. Then we have Seidl, who has shown that milk can be sterilised by waves of length between 1.5 and 3 metres; and now comes the news that the distinguished German professor, Esau, has cured mice of tuberculosis by the application of 2-metre waves. On the other hand, an overdose will kill a mouse in a few seconds (and from America, by the way, come reports of severe headaches and feverishness produced in engineers by exposure to $5\frac{1}{2}$-metre waves).

The "Ultra-violets."

Rays in the ultra-violet region are just as attractive—there seems to be some mysterious spell in the title "ultra . . ." These rays are turning out to be of enormous use in detecting counterfeit banknotes, forged documents, and false jewellery. There seems also to be scope for their use on a large scale for purifying the water of public baths. There are so many remarkable uses for them that it is hardly necessary to mention their employment for invigorating human beings, racehorses and racing greyhounds. Listen to this: For years the ardent silkworm breeder (on whom depends the whole of the real silk industry) has flinched at the word "grasserie," rather—I think—as the devout bee-keeper winces at the mention of the Isle of Wight. For it is the name of a fell disease which attacks his pets: it is so

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There Are More Things . . .—

deadly that immediate diagnosis is tremendously important in order that the invalid may be removed before it can spread the infection. Until recently it was almost hopeless to try to detect it in time: it is practically impossible to feel a silkworm's pulse, and there are no other symptoms to go by. But now it has been found that a particular ray in the ultra-violet region (3650 Angstroms) reveals small yellow spots, faintly fluorescent, on the second day after infection. One cannot help wondering whether some such method of diagnosis might not be possible for human ailments. Is there not a chance that long before the rash appears in—say—measles some change has taken place beneath the skin which could be revealed by ultra-violet or some other radiation? How about it, O Medical Researchers?

The "Ultra-microscope."

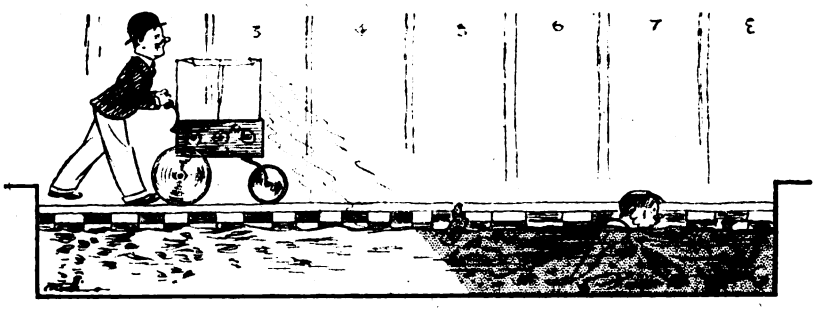
Writing the words "medical researchers" in connection with "ultra" makes it almost inevitable for me to speak about the ultra-microscope, although this is just old enough to make me apologise to those of my readers who already know all about it. Its development was such a neat bit of work, and its utility is so great, that it would be a shame not to mention it. Improvement after improvement was made in microscope methods and apparatus till at last such enormous magnifications were reached that the workers found themselves up against a brick wall: all apparently rational steps to increase the magnification still further met with failure. Then it was realised that with the magnification aimed at the small details were so small that they were comparable in size with the waves of light by which they had to be viewed. Imagine yourself in a nightmare trying to rule a straight line with a pencil so huge that its point was nearly as large as your ruler—and you will appreciate the difficulty. So it seemed for a time as if the limit of magnification had been reached till an ingenious researcher thought of replacing the light rays by ultra-violet—so that the reasonable proportion of wavelength to size of detail was restored, and new possibilities in the way of magnification were opened up. A very pretty bit of work, I think.

The "Ultra-micrometer."

In this device, which measures infinitesimal changes in size, we get back to triodes and grid leaks—fauna and flora more familiar to the inhabitants of the wireless world. It is an amazingly sensitive measuring instrument: if you put in it a piece of fairly stoical impervious material—such as a piece of very hard flint —and turn on the loud speaker while one of our average summer weather forecasts happens to be on, at the words "a deep depression is approaching . . ." a distinct shrinking on the part of the flint will be indicated on the instrument. But this device is only an isolated example of the wonderful technique of vast magnification and astounding accuracy in measurement recently presented to us by wireless research; a technique which is a happy combination of the principle of heterodyne tuning, piezo-electric or tuning-fork frequency stabilisation, and amplification by valves. I do not know what the limit of this latter process is, but I know that a friend of mine works consistently with overall amplifications between 5 and 10 millions. As for accuracy in measurement, let me give you an example.

Speaking Disrespectfully of the Equator.

This used to be one of the things that were not "done"; being myself one of the older generation I do not much like mentioning the following result of the new technique: but it is a vivid example, and, after all, one must move with the times. . . . "Engineering physicists are beginning to question whether the accuracy of the rate of the earth's rotation round its axis is sufficient for their measurements. If the length of the day alters by about one second in ten years this would soon cause an appreciable discrepancy between reference standards. . . ." So writes a distinguished engineer, and, however much one may disapprove of it, the fact is so: one second in ten years works out at about 1 in 300 million, and already our new methods allow us to measure things to within about 1 in 100 millions. The present standard unit of time is the mean solar second, and if this is varying—as seems quite likely—by 1 in 300 millions, a standard based on it to-day (say a standard microfarad condenser) might be appreciably different from a similar standard built thirty years hence: which would be very disconcerting.



Purifying the water of public baths.

. . . . . .

In fact, it is *all* very disconcerting: I don't know what the Government is coming to. . . .

THE NEW KILO-MAG FOUR.

In next week's issue is to be described a revised version of the popular "Kilo-Mag Four"; (two H.F. stages with S.G. valves, followed by anode bend detector and one L.F. magnifier). All the features of the original set are retained; in addition, constructional work is greatly simplified by the adoption of a new form of screening.

The design is simple and straightforward, and includes only such additions as are strictly necessary to allow full amplification to be obtained with complete stability.

Selectivity can be readily adjusted to suit varying receiving conditions—even the most difficult.

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CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS.

Sir,—I, personally, have found the R.S.G.B. of great help to me on all matters when I have asked for help and, to my certain knowledge, no stone is left unturned in doing anything which may further the cause of amateur radio. One of your correspondents thought fit to sneer at conventionettes and ham jests. Doesn't it occur to him that these are functions which serve a very useful purpose in enabling members to get together and, if necessary, air any grievance they may have. The statement made by "The C.G." that the Radio Society only helps their own members (in matters pertaining to licences), to the exclusion of any others, is scarcely correct, as anyone who will take the trouble to enquire will find for himself.

In conclusion, I would suggest that before writing to *The Wireless World* with a wholesale denunciation of the R.S.G.B. and its alleged incapability to help the amateur the people concerned should approach that Society with a view to ensuring that their views are justified. C. S. BRADLEY, G.2AX.

London, N.8.

Sir,—The R.S.G.B. developed from the Wireless Society of London, which was primarily used as a medium for spreading technical knowledge of radio among its members. In the early days such a society was the only medium in this country for the interchange of views, with the exception of *The Wireless World* and *The Radio Review*. On the advent of broadcasting the further interest aroused was met by the issue of many more publications, and the development of your own good paper, together with its sister, *Experimental Wireless*, has removed the need for a society for technical knowledge.

The transmitting amateur was still left uncatered for as regards political and legal questions. The R.S.G.B. tried to make itself the medium by which this could be done, but owing to its lack of general interest and unsatisfactory administration the average transmitter was not willing to join it. This lack of support has been the chief reason why the outside transmitter has been ignored, and has resulted in the lack of power of the R.S.G.B. The R.S.G.B. appears to assist only its active members and those who can make enough noise at H.Q. to be heard. It has neglected its rank and file, who have consequently allowed membership to lapse. The ever-present vicious circle appears here.

The R.S.G.B. cannot by any stretch of imagination claim to represent the amateurs of this country. If it desires to do so it must change its outlook. Let it develop some of the A.R.R.L. spirit, let it be interested in all transmitters, be they brass-pounders or serious workers; let it make a public statement as to its policy and actions: let it look after every single transmitter in this country; then, and only then, will it be supported by the transmitters.

Transmitters, it is up to you to show a united front against the onslaughts of such persons as B. Gladstone, and to have your views expressed to the authorities by a body which you support.

Croydon, Surrey. "AMATRAN."

Sir,—Congratulations on your Editorial *re* "Amateur Status." It is time something was done to give the amateur movement fair play and a sound foundation. There is one point I should like to stress, which is as follows: There are many who have taken up wireless as a hobby, first in connection with broadcast reception. After a time fancy has turned to ultra-short wave reception. The next step is a desire to enter the field of amateur transmission, but two points have to be taken into consideration. The first point is that of cost. A transmitter using one of the many good makes of valve, with its attendant power supply and meters, is so expensive that many amateurs (including myself) have to rule out transmission on such a scale. The way out is that of using a low-power transmitter which uses an ordinary type receiving valve adapted for transmission. With this valve, a few home-made coils, condensers, and other small parts, a cheap transmitter can be built which can send out signals receivable as far away as Morocco.

This all sounds very nice, but then the G.P.O. regulations step in—a Morse test by a P.O. official, a wavemeter costing pounds, while one is not allowed on the ultra-short wave without proof of experience. Now why should a man have to pass a Morse test if he only wants to transmit on telephony, and why should anyone desiring to use a low-power transmitter of the type mentioned have to conform to the letter with regulations which govern the working and plant of the commercial equipments? It is quite time that the under dog had a chance. Could not the regulations be made easier and some small concession granted the users of fly power transmitters so that they might obtain practical experience under working conditions? I feel sure that transmission on these lines could be allowed without so much red tape, and a waveband could be granted where no harm would be done. A. W. M.

Middlesbrough.

Sir,—In a letter by a rival association it is said that the R.S.G.B. is only a glorified London society. How this impression has come about is hard to imagine; any amateur in the world can become a member. It is affiliated to the I.A.R.U., and holds meetings in all the big provincial centres to discuss amateur radio, and any suggestions made at these meetings are made use of at headquarters.

The position of the radio amateur in Great Britain is, one must admit, not a very happy one, but other countries are far worse off, and the only way to obtain further concessions is to get the P.M.G. to see the true requirements of the radio amateur. This cannot be done in a few weeks, but if a united front is put forward in time I believe we shall be in the same position as the United States amateurs, except, perhaps, in the handling of messages. A. S. WILLIAMSON, BRS.26.

Sheffield.

THE "NON-TRANSMITTING" TRANSMITTING PERMIT.

Sir,—In congratulating you on having once more stepped in at a critical time with a warning to the amateur organisations of this country, I would like to draw your attention to what I consider to be a somewhat strange action on the part of the Post Office.

Recently I applied for a transmitting permit, and after furnishing the customary particulars I was informed that I might be allowed to use an artificial aerial. Such a proposal is, of course, a good one, as much real experimental work can be carried out with a non-radiating tuned circuit. I cannot understand, however, what the P.M.G. has to do with non-radiating laboratory equipment, and why I should be asked to pay a fee of 10s. to carry out my electrical experiments. Surely his powers are limited only to the use of apparatus for communication purposes? This question must have arisen before, and perhaps some of your readers can enlighten me.

London, N.W.3. "STUDENT, I.E.E."

ELECTRONIC OR ELECTROLYTIC?

Sir,—In a current advertisement it is stated that the excellent Westinghouse rectifier is purely electronic in its action. Can any reader please explain what is the precise meaning of this statement?

An electrolytic action is surely the evidence of an electron flow. By using the expression electronic in order to signify "non-consumable" confusion is certain to arise between the action of the metal rectifier and the thermionic valve. In the latter case the use of the term electronic is no doubt permissible, meaning, as it does, the passage of an electron stream through a rarefied gas. L. CLARKE.

London, S.W.7.

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By Our Special Correspondent.

Testing at Brookman's Park.—Exit a Spark Station.—The "Proms."

London Regional Testing.

Tests have already begun on a closed circuit at the London Regional station, Brookman's Park, and it is probable that the station may begin radiating, out of broadcast hours, within the next week or two. But it is stoutly asserted at Savoy Hill that "service" transmissions must not be expected before the end of the present month. However, it looks as if people who go away on holiday and forget all about the Regional Scheme will have a breathless moment or two when they switch on again in September.

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Overcoming Obstacles.

Meanwhile, a faint shadow of doubt still lingers over Pole Moor, Slaithwaite (*Slewitt*, if you please), where the B.B.C. engineers believe they have found the ideal site for the Northern Regional station. The B.B.C., it seems, is finding once more that the course of true broadcasting never runs smooth, especially when there are tenant farmers to be reckoned with. However, present obstacles are not regarded in a very serious light, and I think it would be safe to wager that Pole Moor will indeed be the site of the Northern Regional.

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Stamping out the Sparks.

Here is good news for London and the south coast. That tireless provider of mush, viz., FFB, Boulogne, is to change to I.C.W. before the end of the year. FFB is one of those offenders whose signals seem to spread all over the dial of the ordinary unselective receiver, their only useful purpose being to indicate that it is 5GB and not the listener's set that has broken down.

In the past the British and Belgian Governments have both made representations to France to curb the activities of FFB, without any pronounced effect. The promised reformation is in compliance with the terms of the Washington Convention, under which all spark stations are to be abolished by the year 1935.

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A Scottish Tattoo.

Probably the last tattoo of the season to be broadcast will be that relayed to 2LO and 5XX on September 4th. This is the Scottish Command Tattoo, which will come from Dreghorn Castle, Edinburgh.

More "Proms" to be Broadcast.

It is generally recognised that the Queen's Hall Promenade Concerts were saved from extinction by the B.B.C., or, in other words, by the money contributed by broadcast listeners in the form of licence fees. No one will assert, therefore, that listeners will be taking more than their due during the coming season because the concerts are to be broadcast on five nights instead of three, as in previous years.

FUTURE FEATURES

London and Daventry.

AUGUST 14TH.—"King Henry VIII" (Shakespeare), arranged for broadcasting by Dulcima Glasby.
AUGUST 15TH.—Cabaret from the Riviera Club.
AUGUST 17TH.—A Vaudeville Programme.

Daventry Experimental (5GB).

AUGUST 11TH.—Selections from the Oratorios.
AUGUST 13TH.—"King Henry VIII."
AUGUST 16TH.—Selections from the Musical Comedies.

Cardiff.

AUGUST 13TH.—"The Prince who was a Piper," a play by Harold Brighouse.
AUGUST 15TH.—"King Lear's Wife," a play in verse by Gordon Bottomly.

Manchester.

AUGUST 11TH.—Special Scouts' Service in connection with the Boy Scouts' Association World Jamboree, 1929, relayed from Liverpool Cathedral.
AUGUST 12TH.—"Captain Cook and the Widow," a comedy by Stuart Ready.

Newcastle.

AUGUST 12TH.—"Shoot and Run," a revue by E. A. Bryan.

Glasgow.

AUGUST 12TH.—A Maritime Programme.

Aberdeen.

AUGUST 15TH.—A Border Programme.

Belfast.

AUGUST 17TH.—Running Commentary on Royal Automobile Club Tourist Trophy Motor Race from Ards Circuit, near Belfast.

The August Programme.

The portions to be broadcast will be the first part of each concert, usually ending at about 9.40, and as the "plums" of the programme generally occur before the interval, listeners stand to gain rather than lose by the new arrangement, which will ensure a "Prom" from 2LO, 5XX, or 5GB nearly every night of the week. The broadcast will usually be from 2LO and 5XX on two nights a week and from 5GB for the remainder.

The "Prom" dates for August are: From 2LO, 5XX, and other stations except 5GB on 10th, 13th, 15th, 16th, 19th, 22nd, 23rd, 28th, and 31st. From 5GB on the 12th, 14th, 17th, 20th, 21st, 24th, 26th, 27th, and 30th.

During the Promenade season (August 10th to October 5th) the London news bulletin will be given at 9.45 instead of 9 o'clock.

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Relays from Belgium.

Last year's experiment of relaying a concert from the Kursaal, Ostend, will be repeated this month. On Sunday next, August 11th, and again on August 25th, listeners to 2LO, 5XX and other stations will hear the programme from the famous Continental resort from 9.5 to 10.30 p.m.

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The B.B.C. at Play.

The tyranny of the microphone was forgotten a fortnight ago when as many of the B.B.C. staff who could tear themselves from work proceeded to the corporation's new playing fields at Motspur Park, Wimbledon, for the inaugural sports. I am told that certain high officials performed the most astonishing feats and that an extraordinarily high official rose to greater heights in his socks.

With so many young men and maidens in the B.B.C., the sports club has a potential membership of 500. The ground covers fifteen acres and contains a splendid pavilion.

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Listeners on Strike.

There are two kinds of listeners' strike, one of which consists in the refusal to pay licence fees. I hear that an affair of this kind has broken out at Innsbrück, Austria, where listeners have decided to sit on their cheque books until the local station puts out a bigger and better wattage. (I really think the B.B.C. should take a note of this.)

The other kind of listeners' strike originated in America about two years ago, when a whole street in one of the "hick" towns of the West objected to certain broadcast items and refused to listen. This may sound rather baboon-like, but as there are no licence fees, how otherwise can they protest in America?

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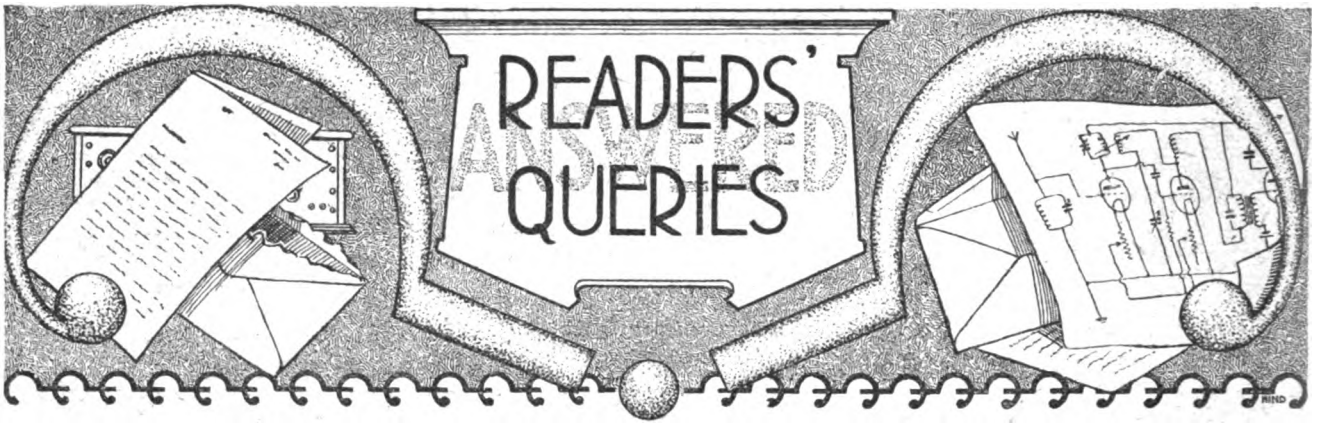

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Making Decoupling Resistances.

I wish to make some de-coupling resistances of about 2,000 ohms; will you suggest a suitable gauge of wire for this purpose? A. P. P.

A good deal depends on the current to be carried by the resistance, but for ordinary use in receivers we suggest either No. 45 or No. 47 S.W.G. Eureka wire. These gauges have resistances, respectively, of approximately 100 and 200 ohms per yard. The first-mentioned is naturally rather easier to work and carries a heavier current without overheating.

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Twin Transmitters.

If and when the proposed Regional scheme of broadcasting comes into being, I take it that those of us who live in the immediate vicinity of the twin stations will be forced to use H.F. amplification in the interests of selectivity—and will then have to throw away this amplification to avoid overloading by local signals. Indeed, judging by experience, some precaution must be taken to obviate overloading, even of the first valve, when the set is accurately tuned—and it will be impossible to operate it in any other condition, or the other "twin" station will interfere. I propose, therefore, to try a simple "pre-H.F." volume control as shown in the attached diagram; my idea is that, for local reception, the H.F. valve grid circuit shall be joined across two or three turns of the aerial input coil, while for long-distance work the grid connection will be restored to its original position at the electrical top of the coil. Will you please comment on my line of reasoning and say if you consider this method of volume control to be sound? Of course, final and critical regulation of signal strength will be effected by a conventional post-detection device. M. T. C.

Your arguments are sound enough, but it is not quite correct to assume that H.F. amplification will be essential to those living near the proposed twin stations.

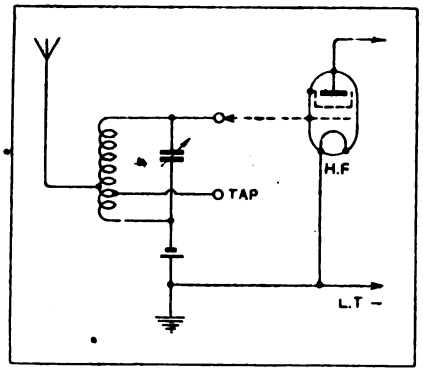

Fig. 1.—Method whereby a small part of the total signal voltage developed across an input coil may be applied to the H.F. valve grid.

Unless distant reception is desired, it will not be necessary to provide the means of H.F. amplification and then to make no use of it; where there is an ample reserve of incoming signal strength, the necessary selectivity is attainable by the use of tuned filters.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Design for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

We think your plan has its advantages; these would probably be most marked in cases where a two-circuit aerial tuner is used, and where it is often impossible to arrange for an extremely weak aerial coupling—which would act as a volume control in much the same way as the H.F. potentiometer shown in your diagram (reproduced in Fig. 1).

o o o o

Cost of Upkeep.

In the published description of the "Flat-Dwellers' A.C. Three" set it is suggested that a fuse carrying approximately one ampere should be inserted in the mains feed lead. Is the total current consumption of that order? If so, I fear the set may be rather expensive to run. G. L. R.

An improvised fuse that breaks down when the current passed exceeds approximately one ampere was suggested solely because it is not an easy matter to find a protective cut-out to operate at an appreciably lower current. Actually, the set consumes no more energy than the average electric lamp, and is, indeed, extremely economical in this respect.

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A Source of H.F. Loss.

The performance of my receiver (two H.F. stages, anode bend detector, and one resistance-coupled L.F. stage) has fallen off considerably, and I am wondering whether this might be due to the fact that the bias cells have been in use for well over a year, and have probably a high internal resistance, as their voltage has dropped considerably. E. W.

Under certain conditions, the use of high-resistance bias cells for H.F. amplifying valves, and more particularly for a succeeding anode bend detector, has been proved to be responsible for a considerable falling-off in efficiency. It is wise to make a practice of changing the cells when their voltage begins to drop rapidly, and it would perhaps be well if we always made a practice of shunting them with a large condenser, preferably with mica dielectric.

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(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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THE SCOUT MOVEMENT AND WIRELESS.

THE celebration of the coming-of-age of the Scout Movement has focused all eyes on the magnificent achievement of this organisation amongst all nationalities throughout the world.

The main purpose of the Jamboree was to bring together units from all over the world so that they might meet one another with common interests and so help to confirm that comradeship which hitherto had been established but with barriers of distance to surmount.

Need for a Means of Communication.

At a time when wireless amateurs throughout the world are showing that distance can so easily be annihilated and that communication from one end of the world to the other is now possible even with very simple wireless apparatus, it would seem to us that the importance of wireless to the Scout Movement cannot be overstated.

We are of the opinion that the Scout Movement would be enormously strengthened if a knowledge of wireless and of how to construct and operate transmitting and receiving apparatus were included as an essential part of the Scouts' training. Every Scout headquarters could have its short-wave station capable of communicating with other headquarters in almost any part of the world, and the interchange of messages through their own short-wave network would maintain as a permanency that personal contact which it has been the aim of the Jamboree to bring about.

Need for Official Encouragement.

We know that wireless is recognised amongst some Scout units and that in individual instances great proficiency has been attained, but we think there is opportunity for wireless to become of far greater importance to the movement than ever it has been in the past if once it is adopted officially at the Headquarters.

There should be very little difficulty experienced in obtaining the necessary sources of instruction for the Scouts. Wireless to-day has become a subject of almost "general knowledge," and every local Scout group could readily obtain the services of a competent wireless amateur, or the aid of the local radio society, to give instruction and train the group in the theory and operation of a wireless set.

The direction in which we foresee the greatest stimulus to the development of wireless in the Scout Movement would be in the provision of facilities which would enable the units to converse with other units abroad, and exchange greetings and compare notes on their activities.

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THE NEW KILO-MAG FOUR.

UNDER this title in the present issue a constructional design is given for an up-to-date revised edition of this receiver which, on its merits, has already proved so extremely popular. The original "Kilo-Mag Four" was described in *The Wireless World* of October 24th and 31st last year, and the receiver has been so successful that it was felt that the time had come to provide a new design having as its particular object the simplifying of the construction, since experience has shown that the previous design was apt to give some trouble to the constructor, particularly in the matter of assembling the components in the screening compartments.

On the question of performance of this receiver there is no need for us to make any comment here, as the design has already earned such a reputation for range, selectivity, and quality.

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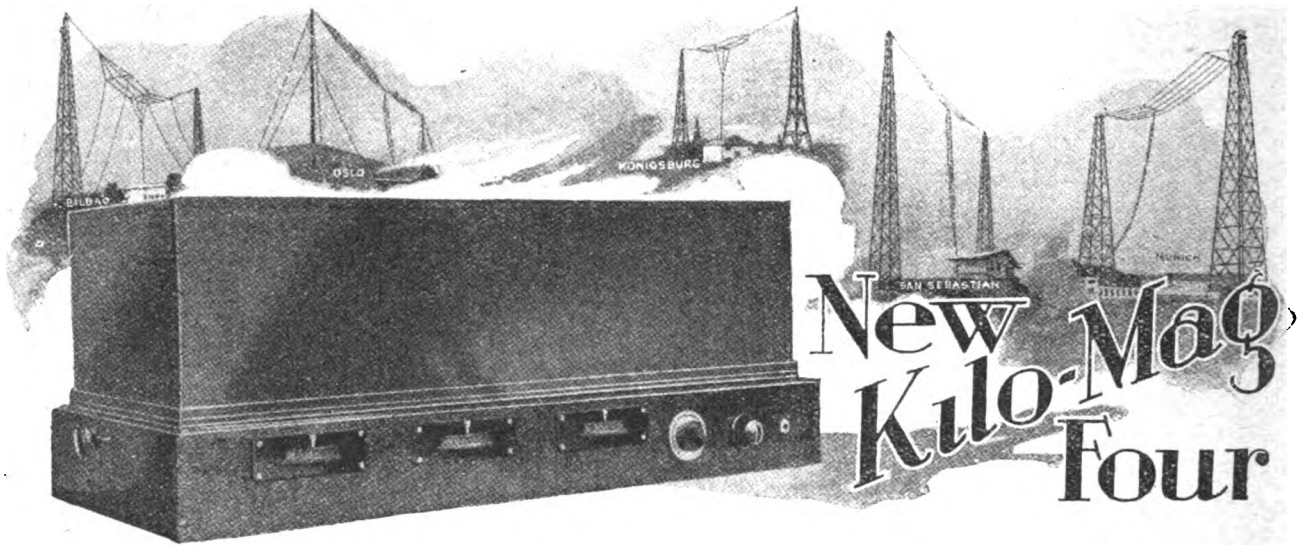

A Re-designed Model of a Popular Receiver.

By H. F. SMITH

ALMOST since the inception of broadcasting in this country, a four-valve receiver has been the favourite choice of the amateur in need of long range and reasonable selectivity—this in spite of the introduction of valves with vastly improved characteristics. The average three-valve set, even with the best modern valves, is still hardly adequate for consistent long-distance reception, although the better designs can admittedly make a good showing when conditions are reasonably good.

Our four-valve sets, in the great majority of cases, include a single H.F. amplifier, detector, and two L.F. amplifiers; the writer would venture the opinion that there will be a distinct tendency in the near future for this valve combination to give way to the alternative arrangement of two high-frequency stages followed by a detector and a single L.F. valve. A receiver on these lines is much more selective, and its capabilities in the matter of volume are ample for all except the comparatively few wireless users who must have an exceptional power output.

New Constructional Methods.

The original "Kilo-Mag Four" [1] was a straightforward receiver to this specification, and represented an attempt to obtain something approaching the theoretical maximum H.F. amplification. To this end, all circuits were completely isolated, but no "frills" or complications were introduced, barring those deemed to be necessary in order to achieve stability. A conventional method of construction was adopted, and here we come to an admitted weakness, although, judged by the ordinary standards applicable to a receiver of its type, it was not difficult to build—indeed, successful examples have been made by the unskilled. But it must be conceded that modern cascade H.F. amplifiers call for radical changes in the methods that have served well enough in the past for sets without metallic shielding, or with only a simple vertical screen; fortunately, the task of devising a scheme of construction

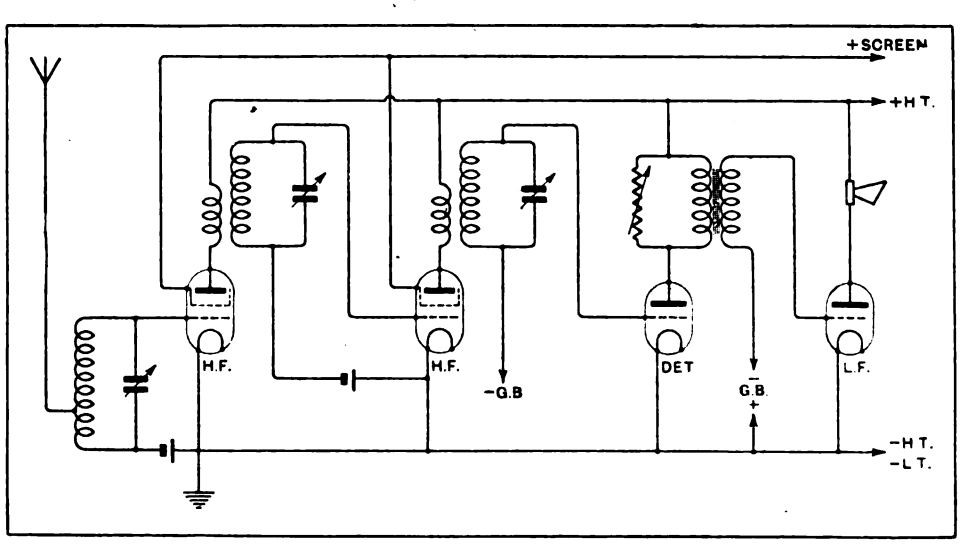

Fig. 1.—Simplified diagram, showing the basic circuit arrangement, without decoupling devices, waveband switching, filament heating connections, etc.

[1] *The Wireless World*, Oct. 24th and 31st, 1928.

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New Kilo-Mag Four.—

for a modernised version of the original "Kilo-Mag Four" has been removed from the writer's shoulders, as *The Wireless World* technical staff has evolved a type of container (described in the issues dated July 10th and July 24th) which at once removes all our difficulties.

The circuit of the new set, of which the essentials are shown in Fig. 1, differs from that of the original only in details: such modifications as have been introduced tend slightly to increase the total H.F. amplification obtainable. With the better valves of the ordinary type, the title of the set may still fairly be considered as being descriptive; a high-frequency magnification of about 1,000 times is readily obtainable, but this figure may be greatly exceeded with the new battery valves shortly to be available.

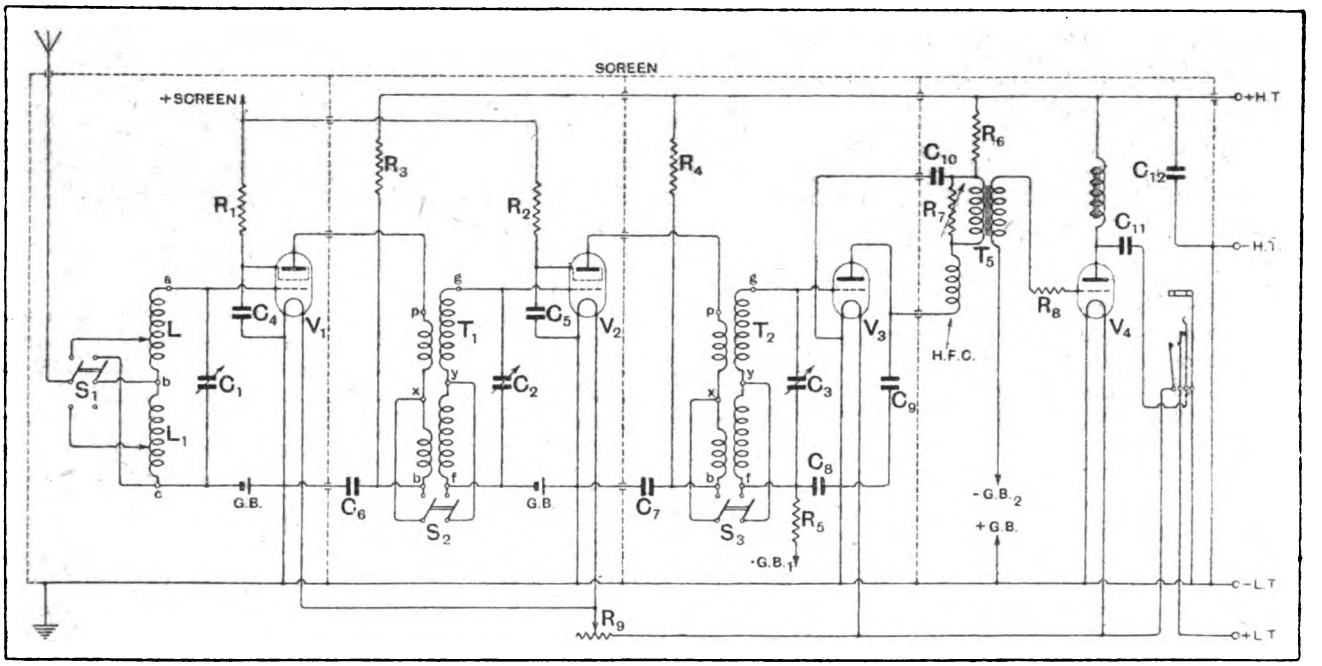

Fig. 2.—Complete circuit diagram. C_1, C_2, C_3, 0.0003 mfd.; C_4, C_5, C_6, C_7, C_8, 0.1 mfd.; C_9, 0.0005 mfd.; C_{10}, C_{11}, C_{12}, 2 mfds.; R_1 R_2, R_3, R_4, 600 ohms; R_5, 10,000 ohms; R_6, 20,000 ohms; R_7, variable resistance, 0–200,000 ohms; R_8, 250,000 ohms; R_9, filament rheostat, 30 ohms. Lettering on coil terminals corresponds with that in other diagrams.

As is now well known, the stage gain of an H.F. amplifier is determined not only by the "goodness" of the valve characteristics and on the thoroughness of the precautions taken to minimise unwanted inter-circuit couplings, but also by the effectiveness of the internal valve screening; considerable advances have been made in reducing residual inter-electrode capacity to an extraordinarily low figure.

It is easiest to trace out the features of the complete circuit (Fig. 2) by comparing it with the simplified diagram already mentioned. Aerial coupling is through an "aperiodic" auto-transformer arrangement in which medium- and long-wave grid coils L and L_1 are connected in series, the unwanted winding being short-circuited by the switch S_1, of which one blade makes the appropriate change of aerial connection. Both H.F. valves (V_1 and V_2) are coupled by means of similar tuned high-frequency transformers, T_1 and T_2. For medium-wave reception, the long-wave windings of both primaries and secondaries (which are connected in series) are short-circuited by the switches S_2 and S_3.

The detector valve operates on the anode bend principle, and derives its negative bias from a battery common to the next stage; a decoupling resistance and condenser (R_5 and C_8) are included in this circuit in order to prevent interaction. It will be observed that an L.F. transformer is used to pass on the detector output to the L.F. amplifier, and that an H.F. stopping choke, with its by-pass condenser C_9, is interposed between the valve anode and this component. In addition, a variable resistance, for volume control purposes, is connected across its primary winding.

Nothing need be said of the connections of the output valve, V_4, beyond mentioning the fact that, as an additional precaution, an H.F. stopper is connected in series with its grid, while a choke filter is interposed in its anode circuit. Loud-speaker connections are picked up through a jack; insertion of the plug automatically closes the filament circuit. This is a convenient arrangement, but is only incidental to the design.

It is not proposed to give a detailed description of the metal container, of which the leading dimensions are given in Fig. 3. This type of cabinet has been described at length in the articles to which reference has been made, and there are indications that manufacturers have not been slow to turn their energies towards the production of commercial designs embodying the basic idea suggested. By the time this article is in print, cabinets with a considerably more pleasing appearance than that of the experimental model illustrated, should be available on the market. It is permissible to stress the need for a perfect electrical seal at the junctions between cover

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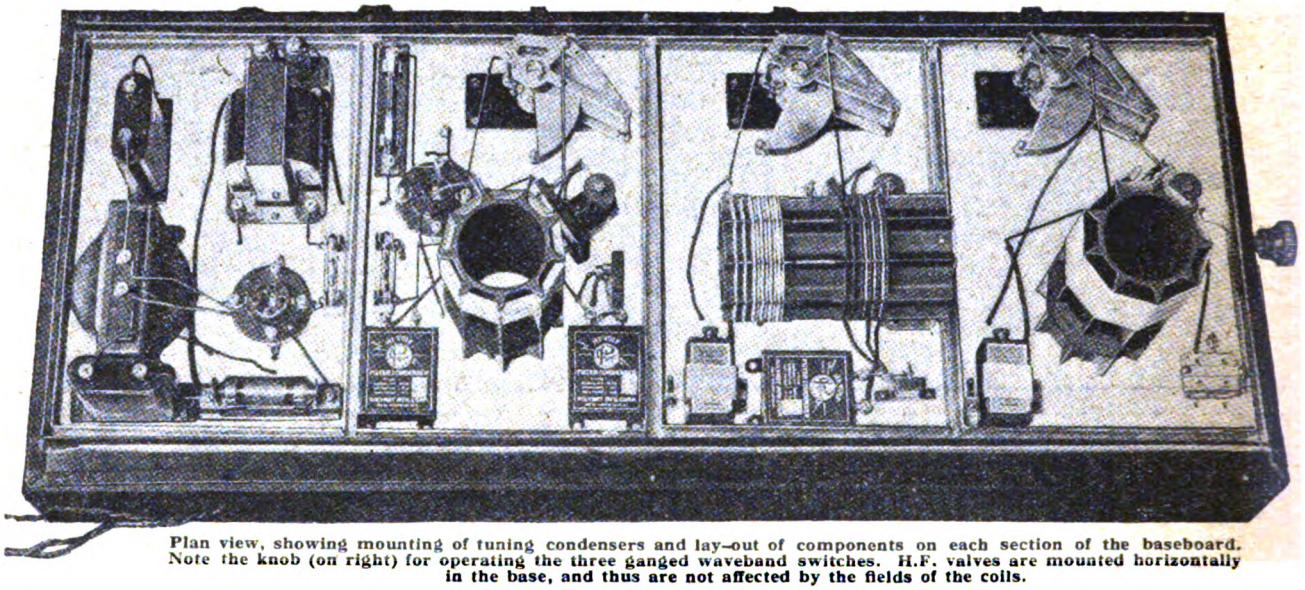
New Kilo-Mag Four.—

and metal base; in the case of the container actually used, this was obtained by placing rolled strips of flexible brass gauze in each of the channels between the base trays, and also round all the four outer edges. The dimensions as given in Fig. 3 show that the container is on the large side. These measurements could be reduced slightly, but the cabinet was designed for more or less universal use in the construction of sensitive receivers, and it would be a mistake to impair its general usefulness in order to save an inch or two.

Before dealing with assembly and wiring it will be well to describe the construction of the special coils. Both aerial-grid inductances and intervalve transformers are made as units, comprising a set of medium- and long-wave windings. This plan is convenient, and tends to simplify both the mounting and wiring of the components, although it is generally possible to effect some economy of space by making up separate coil units for each wave band.



Plan view, showing mounting of tuning condensers and lay-out of components on each section of the baseboard. Note the knob (on right) for operating the three ganged waveband switches. H.F. valves are mounted horizontally in the base, and thus are not affected by the fields of the coils.

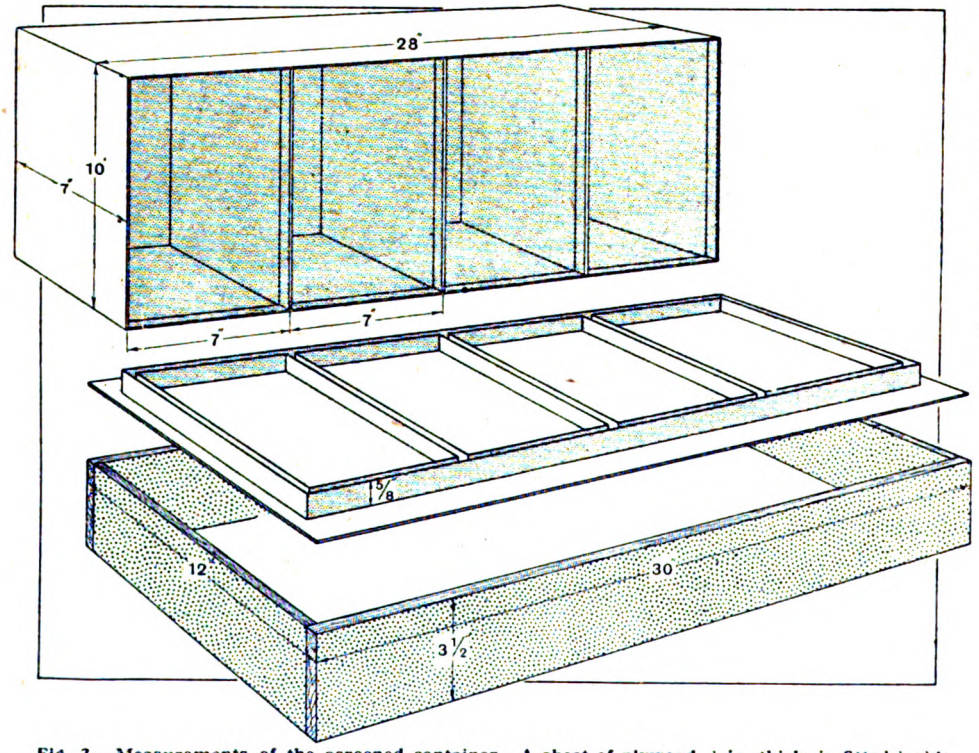


Fig. 3.—Measurements of the screened container. A sheet of plywood, ¼ in. thick, is fitted inside the base tray, with its upper surface flush with the edges.

The aerial-grid coils L, L_1, of which a sectional sketch is given in Fig. 4 (A), are wound on a 6in. length of "Becol" 9-ribbed ebonite former. The short-wave section is a simple solenoid winding consisting of 65 turns of No. 26 D.C.C. wire tapped at several points round about the 8th turn from the earthed end (*b*) for connection of the aerial lead. The long-wave coil is wound in slots, of which the dimensions and positions are given in the diagram, and consists of 210 turns—six sections of 35 turns—of No. 32 D.C.C. wire. Taps at the 15th, 20th, and 30th turns from the earthed end (in connection with the soldering tag marked *c*) are provided; these tappings, together

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LIST OF PARTS.

3 Variable condensers, 0.0003 mfd. (J.B. Log).
5 Fixed condensers, 0.1 mfd. non-inductive (Polymet).
1 Fixed condenser, 0.0005 mfd. (McMichael; clip-in type, with base).
3 Fixed condensers, 2 mfds. (Ferranti).
2 Valve holders, horizontal type (Aermonic).
2 Valve holders (Godwinex).
4 Decoupling resistances, 600 ohms (Graves Bros.).
1 Wire-wound resistance, with base, 20,000 ohms (Ferranti).
1 Grid leak type resistance, 10,000 ohms (Loewe).
1 Grid leak type resistance, 250,000 ohms (Loewe).
2 Resistance holders, porcelain (Bulgin).
1 Variable resistance, 20,000 ohms (Rotor Ohm).
1 Filament rheostat, 30 ohms (Igranic; porcelain).
1 L.F. transformer (Brown).
1 L.F. choke, 32 henrys (Pye).
1 H.F. choke (McMichael; "Junior").
1 2-way connector (Athol).
3 Switches, D.P.D.T. (Utility; knob pattern).
3 9-rib ebonite formers, 6-in. long (Becol).
2 Single dry cells (Ever Ready; "0" size).
1 Grid bias battery, 16½ volts (Siemens).
1 Jack, single circuit open, filament control (Edison Bell).
1 Metal container with wooden base.
3 Special edgewise dials.
Brass strip, wire, screws, ebonite, etc.

Approximate cost, excluding cabinet and dials, £7 10s.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed, and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

with those on the coil L, need only be of a temporary nature, as it is intended that the aerial connection will be permanently made to the point found by trial to give the best compromise between the requirements of sensitivity and selectivity. Care should be taken to see that both windings are in the same direction; that is to say, either one should be a continuation of the other.

A simple mounting is provided in the shape of a wooden plug fitting into one end of the coil former, through which a screw is passed into the baseboard.

The medium-wave H.F. transformer secondaries differ from the corresponding aerial-grid coil in that they are wound in slots, a series of primary coils being sandwiched between the secondary sections. A transformer of this kind is quite effective, as the requirements of close magnetic coupling and low inter-winding capacity are fulfilled, while the work of construction is much easier than if the primary windings were carried on spacing strips in

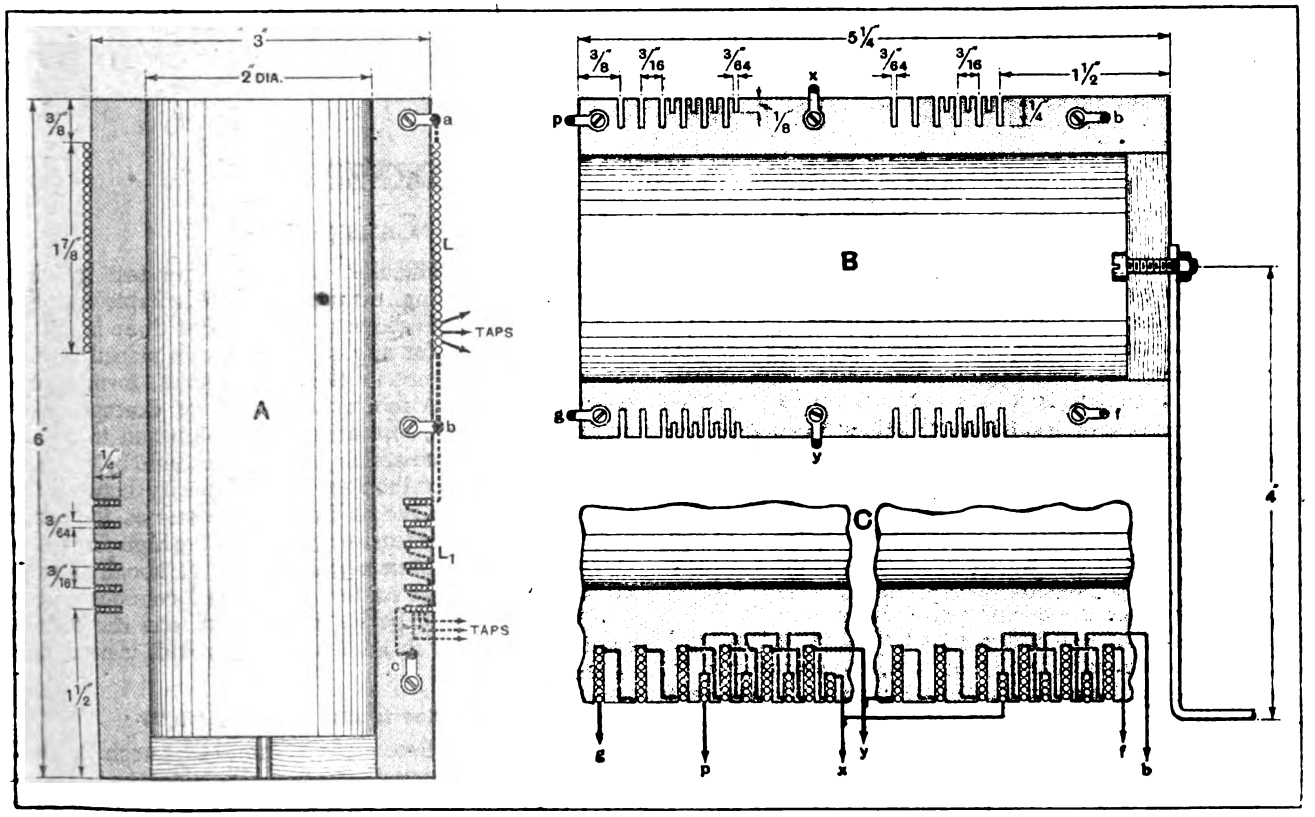

Fig. 4.—Details of coil formers and windings. Diagram A (on left) shows the aerial-grid coil assembly; diagrams B and C show, respectively, dimensions of slots and method of winding and connecting the H.F. transformers. One of these is mounted horizontally on a light metal bracket as shown, while the other (T_2) is mounted vertically by means of a wooden disc.

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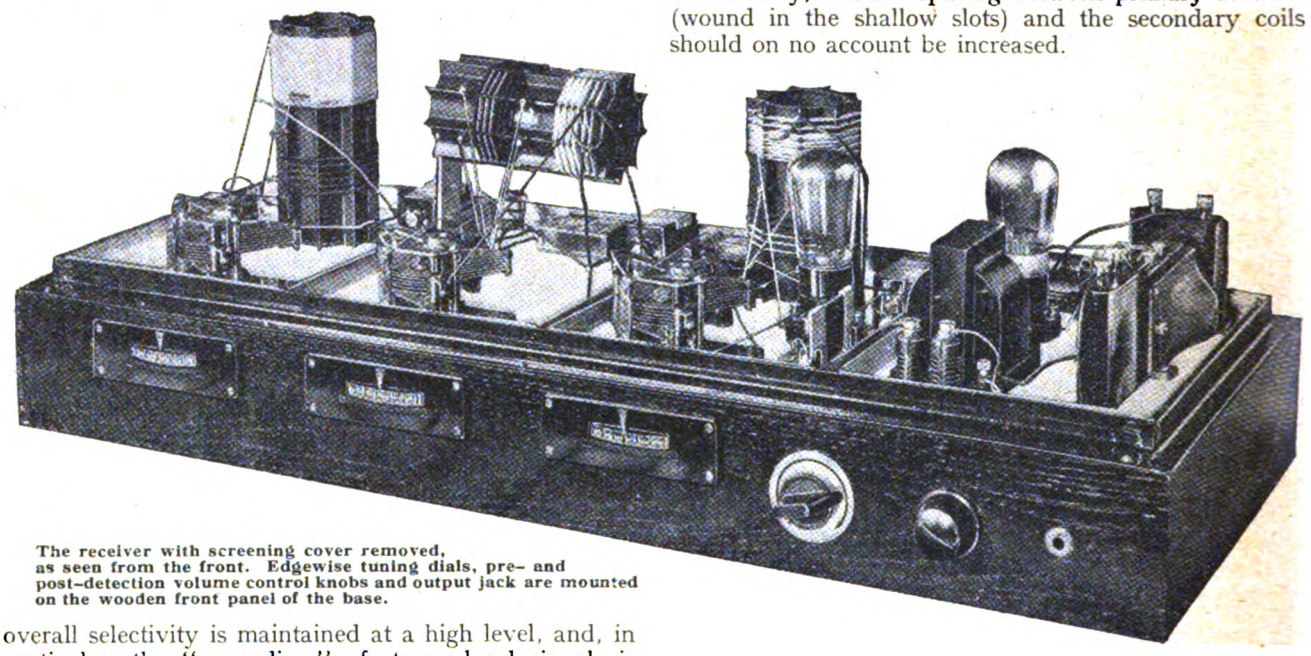
New Kilo-Mag Four.—

the more conventional manner. Admittedly, these section-wound coils have a higher H.F. resistance than single-layer solenoids of the optimum gauge of wire, but their "goodness" is quite adequate for the present purpose; by using a still better coil for the input circuit, overall selectivity is maintained at a high level, and, in particular, the "spreading" of strong local signals is restricted.

Preparation of the formers for the H.F. couplings is illustrated in Fig. 4 (B), although it should be pointed out that the marked dimensions of the slots must be taken as approximate, as a good deal depends on the thickness of the wire covering, and on the amount of tension applied in winding. The slots may be deepened slightly if necessary, but the spacing between primary sections (wound in the shallow slots) and the secondary coils should on no account be increased.



The receiver with screening cover removed, as seen from the front. Edgewise tuning dials, pre- and post-detection volume control knobs and output jack are mounted on the wooden front panel of the base.

(To be concluded.)

IMPROVISING A SMALL CONDENSER.

How Twisted Flex may be Used in an Emergency.

IN testing a newly built receiver containing a stage of high-frequency amplification, it is often necessary to connect the aerial temporarily to a tuned circuit that was designed to tune over the desired range without any such addition. If, for example, a 1-v-2 set fails to give the signals expected of it, the first test would probably consist in attaching the aerial to the secondary of the H.F. transformer, coupling the first valve to the detector, and connecting telephones in the plate circuit of this valve to find out whether the local station can be heard at the expected strength for a one-valve receiver. If all seems well at this point, the aerial and the telephones are moved, valve by valve, out from the detector, so checking the performance of each valve separately.

If such a scheme of test is proposed—and it is a very informative one—it is annoying, to say the least of it, to find that the addition of the aerial capacity to the grid circuit of the detector has altered the tuning range of that circuit to such an extent that the stations to which it is desired to tune for test purposes cannot be tuned in.

If this discovery is made it is not necessary, as at first sight might appear, to abandon the test, for a condenser of small capacity in series with the aerial will speedily circumvent the difficulty. Probably the test is being made in the evening, no condenser of suitable capacity is to hand, and the shops are shut. But there is still no need for despair, for any two conductors placed near to one another, but not in electrical contact, form a condenser of sorts. A foot of twin flex, for example, may be commandeered, one wire being connected to the set and the other to the aerial, both connections being made at the same end of the flex. The capacity between the two wires, though not as free from losses as the purist might desire, will at least serve to pass the high-frequency currents through from aerial to set. Although there is no slow-motion dial on this improvised condenser, it is variable. If less capacity is required, one can always cut the flex, or, if in an economical mood, it need only be untwisted.

Familiar to the "Old Hands"?

The suggestion here made is familiar enough to "old hands," but there must be many experimenters to whom the idea of using a pair of insulated wires twisted together to play the part of an emergency small condenser will come as a novelty.

A. L. M. S.

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CLOCK SETTING by WIRELESS

Automatic Synchronisation from Time Signals.

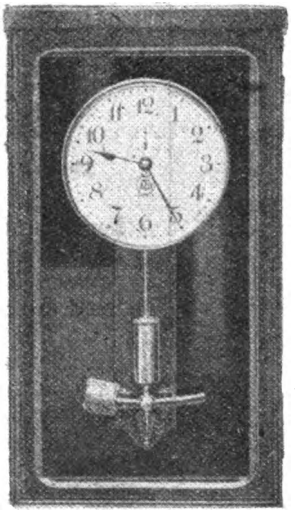
LISTENERS who have tuned in *Radio - Paris* shortly before 10.40 a.m. or 6.25 p.m. will have heard the announcement of the special time-signals for automatic clock-setting by wireless, followed by a series of from six to ten rhythmic dots, ending at the exact times mentioned.

To take advantage of these time-signals two special devices are required (in addition to the ordinary receiver), viz., a relay and an electrically driven clock.[1]

The photograph shows the construction of the relay equipment, and Fig. 1 gives the connections. It will be seen that the audio-frequency currents pass through the primary of a transformer permanently connected in series with the loud speaker, and that the valve amplifies and rectifies these audio-frequency currents, thus producing a series of short direct-current impulses through the coil. In the field of this coil is an armature to which the pendulum is attached. The period of this pendulum being adjusted to be the same as that of the rhythmic dots, the movement of the pendulum builds up until, after three or four impulses, it becomes large enough for the hook C to pick up the contact A and pull it into contact with B on each swing to the left. It should be noted that A is very flexible and thus escapes from C after the contact has been made.

Thus, after the first three or four dots of the time signal, the relay sends out a series of direct-current impulses from the four-volt battery to the clock—one for each dot. The damping of the pendulum is such that it ceases to swing almost at once after the termination of the series of dots, and therefore no further direct-current impulses are transmitted to the clock. It will be obvious that this principle of employing a pendulum prevents the relay from being actuated by signals other than those having the correct periodicity; indeed, it is stated that the time signals can be used even when sent out simultaneously with music.

[1] The French electrically-driven clock here referred to is the "Ato."



The wireless synchronised clock.

The batteries indicated on Fig. 1 are those of the receiver (4 volts is the standard voltage of the French receiving valves), no separate batteries being needed.

A point of interest is that *any* rhythmical time-signals can be used (as, for example, the "vernier" dots from the Eiffel Tower, or the Daventry dots), provided that the period of the pendulum is adjusted accordingly.

Fig. 2 shows a simpler type of relay, in which the signals actuate a telephone receiver permanently connected in parallel with the loud speaker. On the diaphragm of this telephone receiver a contact is fitted, the movement of the diaphragm thus rhythmically *breaking* the circuit through the coil of the pendulum. To avoid waste of current, a switch must therefore be fitted in this circuit, and it would appear desirable that the switch should also disconnect the relay itself, though this refinement is not included in the makers' specification.

Human Element Avoided.

The simpler type of relay can be used only with stronger signals and where little parasitic noise exists. It is stated that with the average receiver (which in France means a superheterodyne) this type of relay is generally satisfactory up to 150 miles from Paris. By the use of the relays the introduction of the human element is reduced to the operation of one switch (to light the valve in one case or to connect the relay in the other) shortly before the time fixed for the signals; while even this task can be avoided by the fitting of special contacts to the clock itself.

The mechanism of the clock is far more complicated, and unfortunately does not lend itself to photographing, but our illustration gives an idea of the general appearance, and incidentally shows that the pendulum used in the relay is very similar to that of the clock itself.

It should be observed, in Fig. 3, that the cross-shaped cam is mounted integrally with the minute hand, on a tube driven *frictionally* by the main driving spindle shown, so that the minute hand

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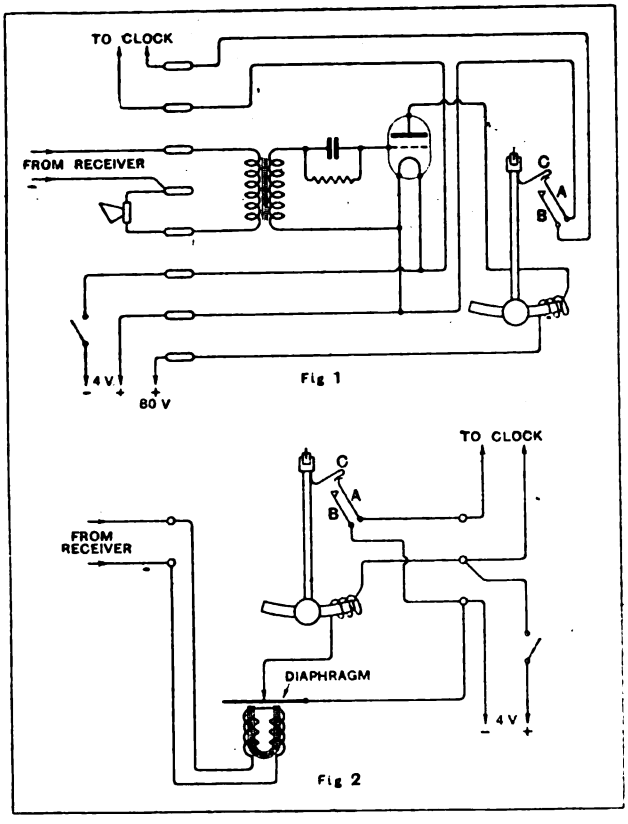
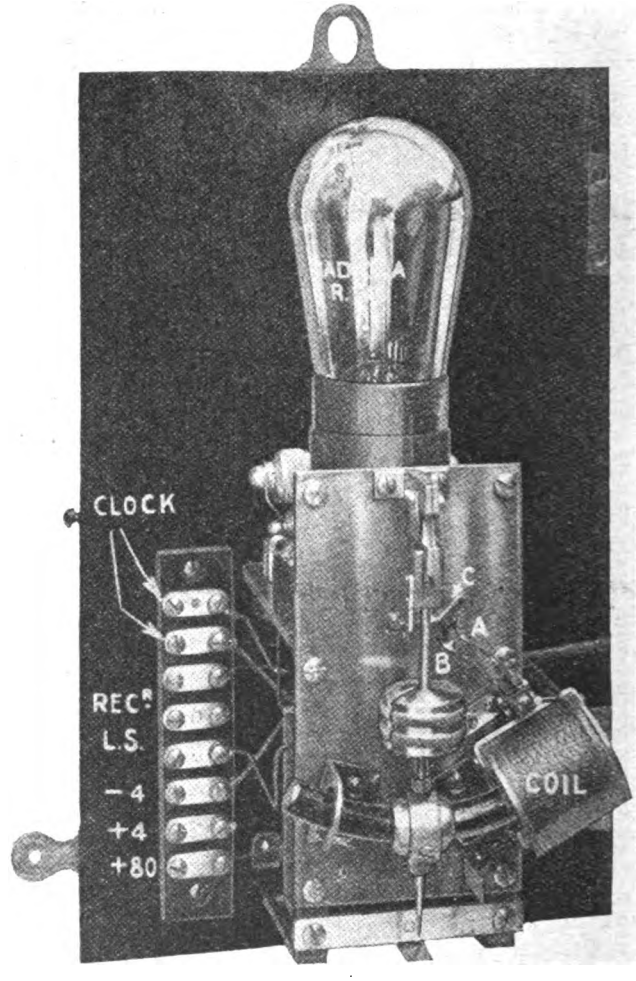


Fig. 1.—(Top) The audio-frequency dot signals cause the anode current to energise the magnet associated with the pendulum. Eventually the pendulum gathers sufficient swing to actuate the contacts A and B. These contacts send out current pulses to the clock. Fig. 2.—Modified form of control pendulum. Here a telephone relay replaces the valve rectifier.

can be moved (with its tube and cam) independently of the driving mechanism of the clock, and, what is equally important, can be *held* in any given position without stopping the clock. The hour hand is driven through a twelve-to-one gearing from the tube of the minute hand and not from the spindle, so that any change made in the position of the minute hand also moves the hour hand to its corresponding new position. Finally, the second hand is also mounted, together with its heart-shaped cam, on a tube driven by friction from the " seconds " spindle.

The direct-current impulses arriving from the relay pass through the coil of the electro-magnet shown, and the double lever is thus actuated by the armature. One arm of this lever enters whichever section of the cross-shaped cam may be opposite it, and thus sets the minute



The relay equipment, consisting of valve rectifier and impulse pendulum.

hand to the position corresponding to this section. At the same moment the other arm of this lever actuates the heart-shaped cam, thus setting the second hand to zero.

On the termination of the impulse, the three hands are released, but each subsequent impulse brings them back to the same positions, and it is not until the final impulse has arrived that the clock mechanism is left free to take charge of the hands again. The limit of correction is about five minutes fast or slow, this being conditioned by the width of the openings of the cross-shaped cam. However, even if such a clock is set only once a week, nothing like this error should occur.

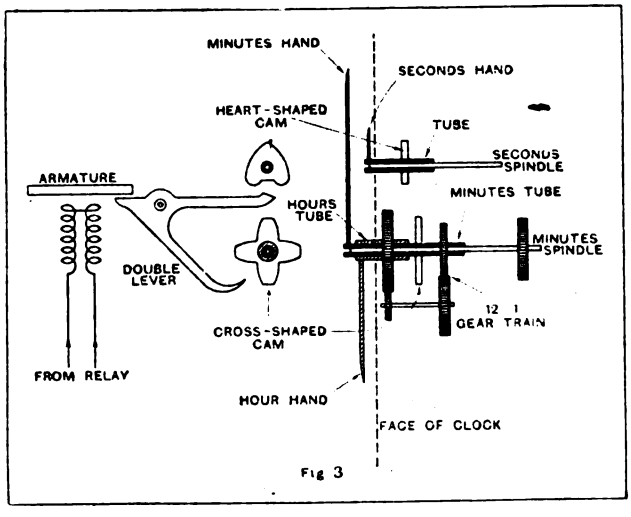


Fig. 3.—Each pulse of current controls the clock mechanism by bringing the minute and second hands to zero. It is not until the dot signals cease that the clock hands are set free to take up the friction drive from the clockwork.

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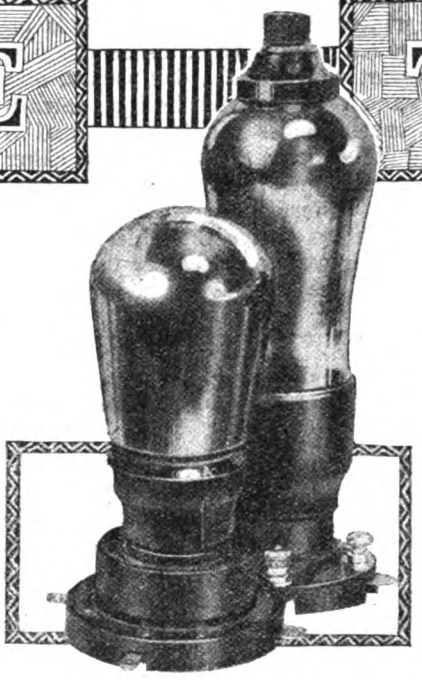
VALVE TESTS



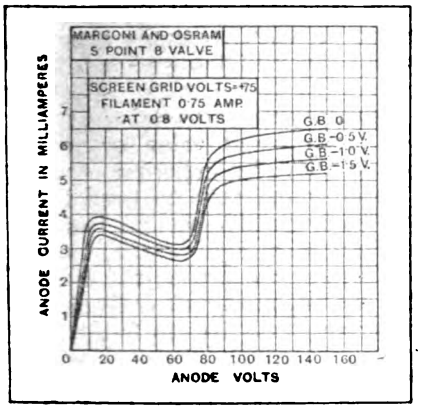
Two New A.C. Valves.

Additions to the Marconi and Osram "Point 8" Group.

THE group of valves which figure in the Marconi and Osram lists as the "point 8" class has hitherto appeared incomplete, since it did not include one of the screen-grid type or a valve which could be used, under all conditions, as a detector. Happily this omission has now been corrected, and two new recruits, the S point 8, and the D point 8, have been added to the list already containing the HL point 8, H point 8 and P point 8. These were tested and reviewed in our issue of April 17th.

S Point 8 Valve.

The S point 8 is a screen-grid valve, the filament being heated direct from the secondary winding of a suitable transformer. It should not be confused with the indirectly heated type. The filament requires 0.8 of an ampere at 0.8 volt. Its working characteristics are comparable with those of the S215, the 2-volt battery-fed screen-grid valve.



Average values under working conditions: A.C. resistance 265,000 ohms, amplification factor 200, and mutual conductance 0.75 mA per volt.

According to the maker's rating, the A.C. resistance—measured at anode volts 120, and plus 80 volts on the screen-grid—is 200,000 ohms, and the amplification factor 160. These constants, however, will alter under different working conditions. As an example, we measured the impedance and amplification factor with plus 75 volts on the screen-grid, and found the average A.C. resistance between 100 and 150 anode volts to be 265,000 ohms; the amplification factor was approximately 200. The mutual conductance, or "slope," came out very much the same as stated by the makers, namely, 0.75 mA. per volt, as compared with 0.8 mA. per volt with 80 volts on the screen. The A.C. resistance will increase with reduction in screen potential, and decrease when the screen volts are raised. Within certain limits the conductance remains the same. In view of the relatively high A.C. resistance under working conditions, the most suitable intervalve coupling would appear to be a 1:1 ratio transformer, but this may not be possible in practice without neutralising the small residual valve capacity in the approved manner.

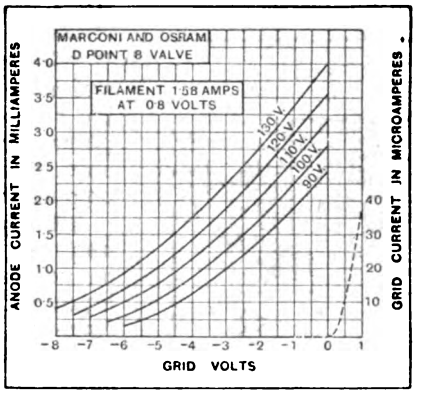
Characteristics measured at 100 volts H.T. and Zero Grid Bias.

D Point 8.	A.C. Resistance Ohms.	Amplification Factor.	Mutual Conductance.
Maker's rating	21,000	14.0	0.52 mA./volt
Specimen sample	26,650	15.4	0.58 mA./volt

The ratio should be, therefore, as near unity as the conditions of stability will allow.

D Point 8 Valve.

Hitherto the stumbling-block with regard to the detector stage has been the difficulty of producing a filament which is hum-free where lit by A.C. direct. This valve is far more susceptible to hum than any other valve in the set, especially when leaky-grid rectification is used. In the D point 8 valve this difficulty is overcome in a satisfactory manner by increasing the thickness of the filament, while still retaining the "point 8" characteristic as regards voltage; the current passed, however, is comparatively large. This valve consumes 1.6 amperes at 0.8 volt. In spite of the nature of the supply, the temperature of the filament remains practically constant. The current consumed is of little importance, even though it is double that taken by the other "point 8" valves, since it is drawn from the mains and the extra 0.64 of a watt will add very little to the operating costs.



Average values under working conditions: A.C. resistance 33,000 ohms, amplification factor 16.5, and mutual conductance 0.5 mA per volt.

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Valve Tests.—

The conductance remains fairly constant over a wide range, and measurements made under normal working conditions as an amplifier with 120 anode volts and minus 4½ grid volts, gave the A.C. resistance as 33,000 ohms; the amplification factor 16.5 and mutual conductance 0.5 mA. per volt.

The D point 8 detector, in common with other leaky-grid detectors, functions best with a small positive grid potential; about 1½ volts is required in this case. Since the filament is lit by A.C., this positive bias cannot be derived from a potentiometer across the filament, and it will be necessary to provide either a small grid cell, or tap into the grid battery from which the L.F. amplifiers derive their bias.

It is well to remember that when using the directly heated class of valves that all grid return leads must be connected to the centre point of a potentiometer, which should be connected across the filament of each valve. As the potential difference between the ends of the filament is only 0.8 of a volt, a resistance of a few ohms each will suffice. These can be made up quite easily by winding a short length of resistance wire on a fibre or paxolin strip and tapping it at the electrical centre.

USEFUL DATA CHARTS. (No. 26.)

The Design of H.F. Transformers.

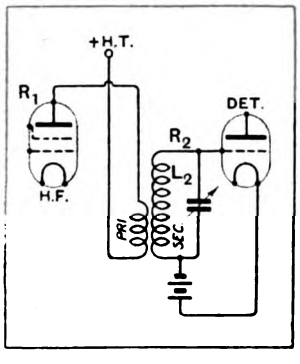
IN designing a H.F. transformer we begin with the secondary circuit which consists of a coil and a variable condenser arranged to tune over the range of frequency required. This secondary circuit is designed exactly as for a tuned anode circuit, and the coil is wound with wire of suitable gauge to make the H.F. resistance as small as possible.

The next step is to design the primary winding, which is in series with the plate of the H.F. valve. The presence of the secondary circuit results in an extra load being thrown into the primary circuit, and it is well known that the stage gain will be greatest when this extra load is equal to the differential resistance of the H.F. valve.

If the transformer were iron-cored the proper turns ratio to obtain this result would be given by the formula, square of ratio of primary turns to secondary turns = differential resistance of valve × H.F. resistance of secondary coil ÷ square of reactance of secondary coil, or

$$n^2 = R_1 R_2 / [2\pi f . L_2]^2.$$

Thus, if the H.F. valve has a resistance of 100,000 ohms, and if the secondary coil has a reactance of 2,000 ohms and a H.F. resistance of 20 ohms, then $n^2 = 10^5 \times 20/4 \times 10^6 = 0.5$, and $n = \sqrt{0.5} = 0.71$, so that the number of turns in the primary can be obtained at once, being 0.71 times the number in the secondary.



The conventional connections for a transformer-coupled screen-grid valve.

Actually we do not use iron in H.F. transformers on account of the heavy losses which would be incurred, leading to flat tuning and diminished amplification; instead we use coils in air, and then the formula given above is no longer quite correct; it underestimates the primary turns required for two reasons, the first being that the coupling between the coils is now less than unity, and the second that the inductance of the primary is no longer proportional to the square of the primary turns, since a shape factor comes in depending on the ratio of the length of the coil to its diameter.

The correction required cannot be specified accurately, since it depends so much on the manner in which the coils are wound. When, as is usually the case, the primary is made of fine wire and wound closely over (or under) the secondary, sufficient accuracy is obtained by increasing the turns ratio obtained from the formula by 10 per cent.

Example.

It is required to design a H.F. transformer for a 100,000 ohm screen-grid valve to work over the band 250-550 metres; the screen-grid valve is followed by an anode bend detector and a pentode.

The secondary coil, which is supposed to be tuned by a 0.0003 mfd. condenser, can be designed from abac 17. If we make its diameter 3in. and length 1.5in. its reactance will be about 2,000 ohms in the middle of the range and its H.F. resistance about 15 ohms when we allow for the load thrown upon it by the detector.

Abac 26 gives the answer for the turns ratio as 0.612, and it is desirable to increase this value by 10 per cent., as stated above, to allow for imperfect coupling and shape factor. The actual ratio is accordingly 0.673. In most cases the turns ratio will be found to be less than unity, but with very high resistance valves of about one megohm, which are now on the market, and long wavelengths, the ratio may exceed unity so that a step-down transformer will be required.

Limitations in Design.

In this method of design no account has been taken of reaction due to internal grid-plate coupling in the H.F. valve, so that it is only applicable when the system does not approach instability, as is usually the case with the screen-grid valve or when the system is neutralised in the case of the triode. Also, the correcting multiplier has only been worked out for a secondary of fixed shape with length equal to half the diameter.

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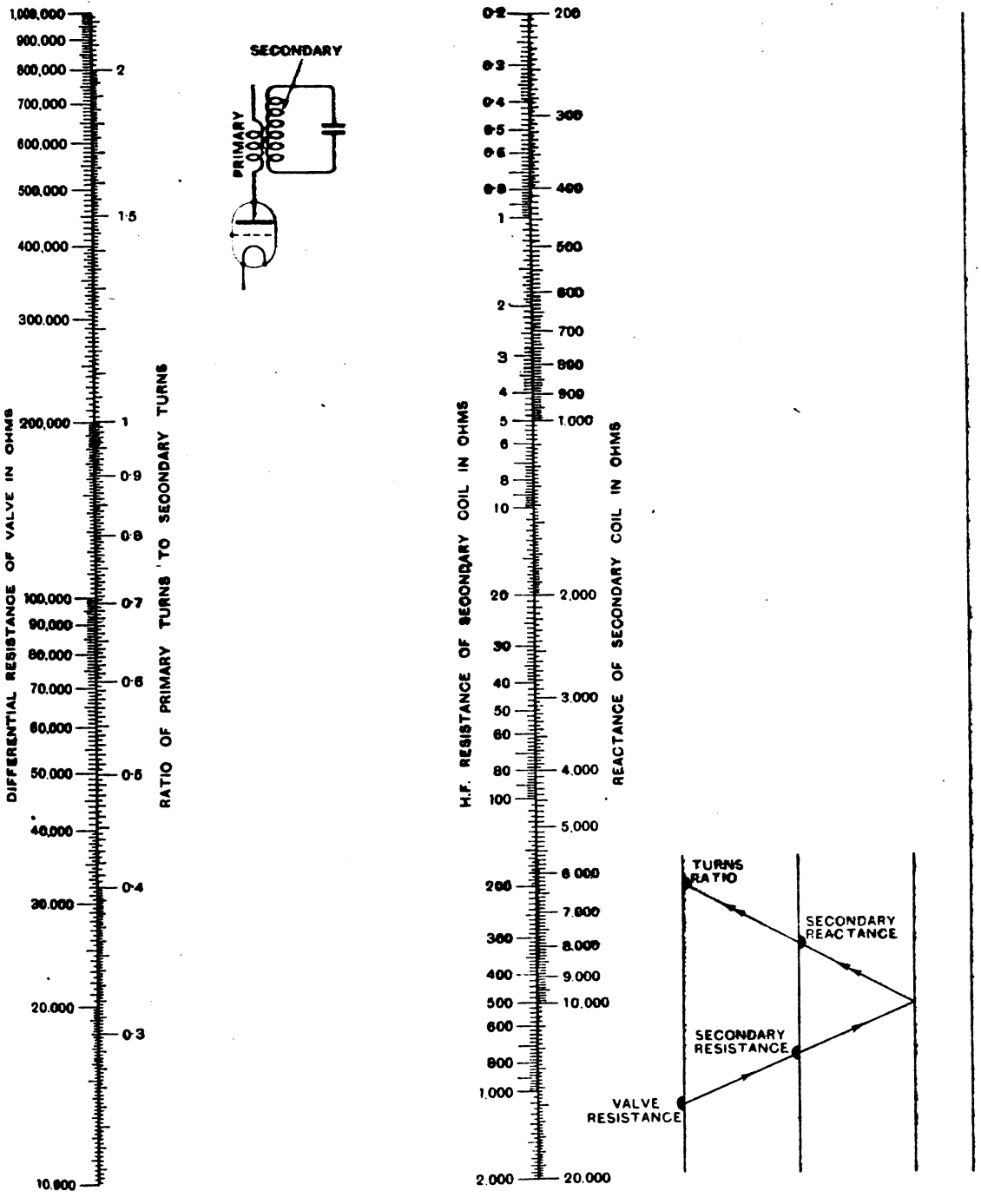

DESIGN OF H.F TRANSFORMERS

W W ABAC

No 26

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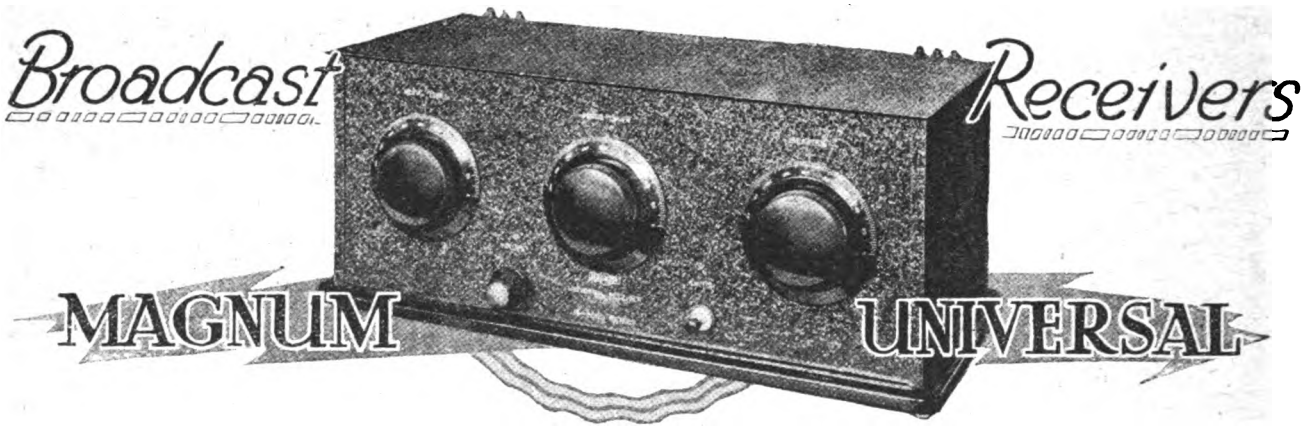
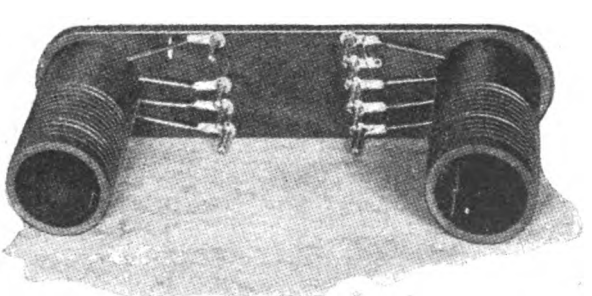


Wavelengths from 15 to 2,000 Metres, with a Circuit including a Screen-grid H.F. Valve, and Pentode L.F. Amplifier.

THIS receiver made its debut at the last Radio Show at Olympia and attracted considerable notice and favourable comment on account of the ingenious design of the interchangeable coil units. Designed primarily as a short-wave receiver it should make a strong appeal to the overseas listener and also to those interested in long-distance short-wave reception in this country. The type of circuit chosen and the interchangeable coils enable the wave-range to be extended to include broadcast transmissions on the medium and long waves.

The circuit of the Magnum Universal receiver comprises three valves, the first a screen-grid H.F. amplifier, the second an ordinary three-electrode detector, and the third a pentode output valve. By far the most interesting and original feature of the layout is the arrangement of the interchangeable coil units. The coil-holder is mounted on the screen partition separating the aerial circuit and H.F. amplifier compartments, and the coils hang downwards, one in each compartment. Pin contacts are mounted on the underside of the horizontal ebonite strip connecting the coils. The aerial circuit consists of a tuned grid winding and a separate aperiodic aerial coil, and is therefore provided with four contact pins. The H.F. circuit carries five contacts, two for a reaction winding and three for the centre-tapped tuned-anode coil. The latter functions as an auto-transformer, giving a step-up ratio. In the case of the ultra-short-wave coils, however, the centre tap is omitted and the circuit is reduced to simple tuned-anode coupling.



"Twintuna" coil unit comprising aerial, tuned grid, tuned anode and reaction windings.

The screen-grid valve is mounted horizontally and passes through a hole in the screen partition. The screen-grid potential is supplied through a variable series resistance which is utilised as a volume control. The anode potential is taken from the same H.T. terminal as the output valve, but a large-capacity by-pass condenser is mounted close to the anode lead. Similar care has been taken to keep the wiring to the screen-grid by-pass condenser as short as possible.

Unwanted Couplings Avoided.

Special Polar condensers with phosphor-bronze ball bearings are used to tune the aerial and H.F. circuits, the object being to reduce intermittent contact noises on the ultra-short waves. It is interesting to note that the wires from these condensers to their respective tuning coils have been run parallel and close together in order to produce a compact circuit with a minimum stray field.

The detector functions as a leaky grid rectifier, the grid being biased from the positive terminal of the 2-volt filament circuit. A separate H.T. terminal is provided for the detector, and the anode current, after passing through the primary winding of the Igranic L.F. transformer, traverses two H.F. chokes in series and then the reaction winding before reaching the anode. One choke is designed for ultra-short waves and the other covers the normal broadcast wavelengths. The degree of reaction is controlled by a variable by-pass condenser shunting the reaction coil and valve.

A neat mounting has been arranged for the intervalve transformer. This is mounted upside down and is secured to the ebonite baseboard by means of the four terminal screws, connections being made to tags fitted underneath the baseboard. A resistance leak is connected across the transformer secondary. The pentode output valve feeds the loud speaker terminals direct without a filter feed circuit or transformer.

A flash-lamp fuse is included in the —H.T. lead and

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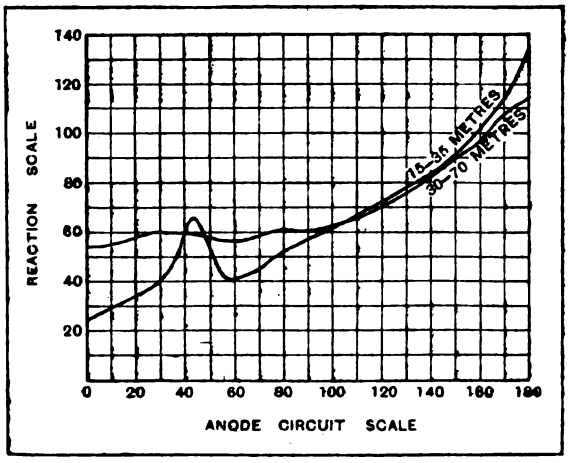
Broadcast Receivers—Magnum Universal.—

the L.T. circuit is completed by a simple push-pull switch.

The metal cabinet is built up of heavy-gauge aluminium plates fitting into channelled corner posts of square



Interior view of the Magnum Universal receiver showing position of "Twintuna" coil unit.

section. The majority of the components are fixed to an ebonite baseboard raised about 1½in. above the base proper. The space under the baseboard has been freely used for wiring, with the result that the interiors of the compartments above the baseboard are comparatively free from wiring. The workmanship in general and the wiring in particular have been carried out with exemplary thoroughness.

The first step in testing the receiver was to check the wave range of each coil unit. The results were as follows:

RANGE (METRES).

Nominal	Measured
Coil No. 1, 15-35	15.3-41.5
Coil No. 2, 30-70	29.9-81
Coil No. 3, 250-550	209-607
Coil No. 4, 1000-2000	717-2020

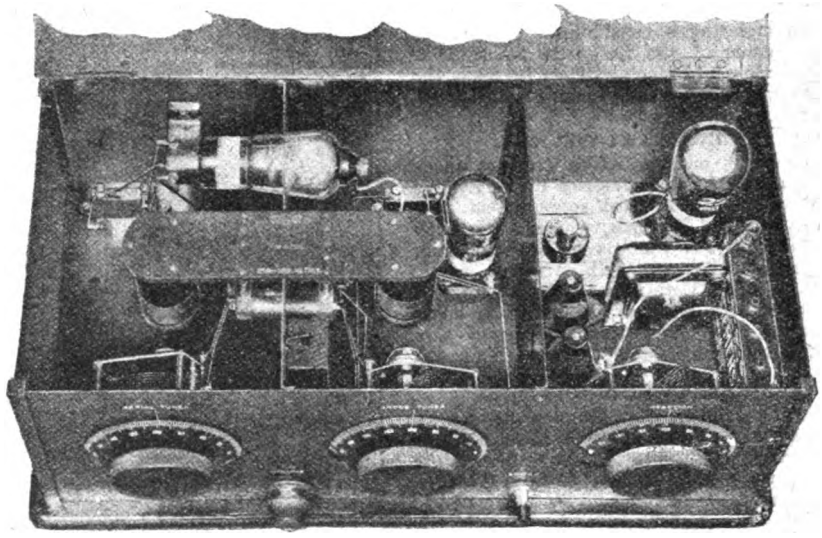
These figures show that the ranges specified are covered with a more than ample margin of safety.

For maximum signal strength and range the volume control rheostat was screwed up as far as it would go to the right and then taken back about half a turn. This adjustment gave best results on all four ranges and is evidently the setting which gives the optimum screen-grid potential. A reduction in volume is obtained on either side of this optimum setting, but in practice it is best to turn the control to the left, as this also reduces the H.T. current consumption. The total H.T. current ranges from 19 to 24 mA., depending on the volume control setting, the optimum value being about 22 mA. A current of this magnitude demands super-capacity dry cells, or, better, still, a suitably designed short-wave mains unit.

The reaction control on both short-wave ranges is smooth and free from backlash. On the medium and long-wave ranges, however, varying degrees of backlash up to 4 degrees of the dial were experienced. It is evident that the makers regard this set primarily as a short-wave receiver, and have accordingly adjusted the grid condenser and leak values for the lower wavebands. Critical adjustment of reaction is less important on the longer wavelengths, and it is only right that the short waves should receive first attention.

During the period of the tests atmospheric conditions were about as bad as they could be. Melbourne (Australia) and Schenectady (2XAF) were received and identified with difficulty, but the performance on European short-wave transmissions indicates that there is nothing seriously wrong with the short-wave sensitivity; under more favourable conditions there can be no possible doubt that the American and Australian stations would be well received.

The performance on the 250-550-metre broadcast band is really excellent. Range and selectivity are good, and we succeeded after dark in tuning-in ten foreign stations in central London during the evening transmission from 2LO. The volume from 5GB is more than the average loud speaker will stand, and the quality of reproduction is worthy of a moving-coil loud speaker. Compared with the medium-wave band, the long waves are disappointing. Considerable reaction is required to obtain good loud speaker strength in London from 5XX. However, provided that one is not so situated as to be dependent solely on 5XX for the B.B.C. programmes, the Magnum Universal Receiver merits the closest consideration of those listeners who wish to supplement first-class reception of British and European broadcasting with occasional programmes from overseas. The makers are Messrs. Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1, and the price of the set is £10, including four "Twintuna" coils, valves and royalty.



Reaction dial settings required to keep the receiver on the threshold of oscillation over the ultra-short wave bands.

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CURRENT TOPICS

Events of the Week in Brief Review.

SPAIN TO TELL THE WORLD.

An unconfirmed report from Spain states that a world-wide short-wave transmitter will be erected on Mount Tibidabo early in 1930. A medium-wave station is already in operation on the site.

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DISTANCE LENDS ENCHANTMENT . . .

A plea for the suppression of man-made static has been lodged with the Belgian Government by the Federation des Sociétés D'Etudes Radio-electriques, which also urges that the erection of powerful broadcasting stations should be forbidden near populous areas.

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HIGH POWER BROADCASTING IN FRANCE.

With a view to securing better broadcast signal strength for Western France, the Bordeaux broadcasting authorities are contemplating a considerable increase in the power of the Lafayette transmitter. According to French wireless journals, the power may eventually reach 30 kilowatts.

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WIRELESS AT THE B.I.F.

Over six months before the opening of the next British Industries Fair only five per cent. of the total space in the new and enlarged Olympia, where the London section of the Fair is to be held from February 17th to 28th, remains unlet. As an indication of the size and importance of the wireless exhibit it is noteworthy that this section will occupy part of the ground floor of the New Hall.

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WHERE LISTENING IS FREE.

To popularise broadcasting no fee is charged for listening in Formosa, which owns a 1-kilowatt station erected in November last by the Tokyo Wireless Telegraph and Telephone Co., Ltd. H.M. Consul at Tamsui, Formosa, states that the number of applications for listening permits exceeded 8,000 in the first four months. Of the receivers in use 80 per cent. are cheap crystal sets, all of Japanese manufacture.

In the spring of 1930 a new 10-kilowatt station is to be opened at Itabashi, near Taihoku.

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WIRELESS AND THE BLIND.

At the recent annual meeting of the Hull and East Riding Institute for the Blind, it was stated that every blind person in the district had been provided with a broadcast receiver. A set maintenance service is carried on by a group of voluntary workers.

IN 1929!

A Sheffield "pirate" stated in court last week that he was unaware that a wireless licence was necessary.

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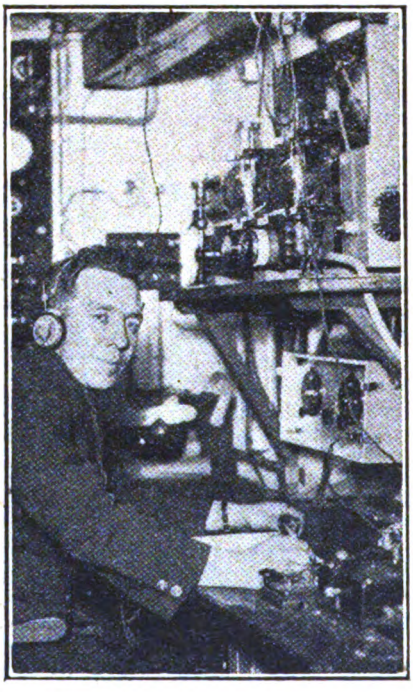
TIT FOR TAT.

By way of protest against the practice of the Copenhagen Municipal Electric Supply Corporation in retailing wireless sets, local wireless dealers have decided not to consume electricity on more than four days in each week.



SOUTHWARD BOUND. Operator Williams in the wireless cabin of the *Discovery*, which has now left Cardiff for Cape Town, where Sir Douglas Mawson, leader of the Antarctic expedition, will join the ship.

PARIS WIRELESS WAR.

There is no decline in the hostilities between the Paris Radio Manufacturers' Union, organisers of the National Wireless Show to be held in October, and the independent manufacturers who are staging an international radio show during September. In its efforts to boycott the international show, the Manufacturers' Union has now forbidden its members to participate.

FRENCH COLONIAL BROADCASTING.

The Eiffel Tower wireless station has discontinued tests on 49.5 metres and will soon resume on 31.5 metres. The object of the experiments is to determine the most suitable wavelength for broadcasting to the French Colonies.

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U.S. RADIO INVASION.

It is understood that negotiations are taking place for the formation of a British subsidiary company to the well-known American organisation, Grigsby, Grunow and Co., manufacturers of electrical goods and wireless apparatus.

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FARADAY ELECTRO-MAGNETIC CENTENARY.

Dates have been fixed for the celebration of the Centenary of Faraday's discovery of electro-magnetic induction, and the proceedings will commence in London on Monday, September 21st, 1931.

At a representative meeting of the Institution in February last the arrangements were placed in the hands of two committees, the first consisting of representatives of the Royal Institution, the Royal Society, the British Association, and other scientific societies, to deal with the purely scientific aspects of Faraday's work in relation to the proposed celebrations; the second committee, called together by the Institution of Electrical Engineers, is concerning itself with the industrial side.

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MORE POWER FROM LATVIA.

The Riga broadcasting station, which has recently been undergoing reconstruction, will shortly increase its power to 6 kilowatts.

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BLIND SPOT IN RUSSIA.

A Russian radio engineer, named Gordejev, who has been experimenting for some time on short-wave transmissions, has discovered totally "blind spots" in the southern part of Russia, writes a correspondent. In a triangle bounded by Odessa, Batoum and Feodosia (Crimea) short-wave reception was found impossible, although signals on medium and long waves were easily obtainable. At Feodosia itself no difficulty was registered.

In order to investigate these peculiar conditions the Soviet authorities have equipped a small steamer, the "Grusia," with the necessary radio equipment, and tests are made throughout the day and night on both 20 and 40 metres with an

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energy of roughly 20 watts in the aerial. The "Grusia" recently left Batoum, and in short stages will follow the coast line of the Black Sea. The call sign: X-UE-2BJ is given at the beginning and end of each transmission.

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STOCK AND SHARES AT SEA.

Share dealing will shortly be conducted at sea on the leading Atlantic liners by means of wireless, according to a recent decision of the Wall Street Stock Exchange to allow two of the principal brokerage houses to establish offices on ships. A "radio circuit" with a special wavelength will probably be employed, and it is understood that the first vessels to be equipped will be the United States liner "Leviathan," the Cunarders "Berengaria," "Mauretania," and "Aquitania," and the French liners "Ile de France," "Paris," and "France."

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STATE-CONTROLLED BROADCASTING IN AUSTRALIA.

Australian broadcasting is now put on a basis of State control by the Federal Government's acceptance of the tender submitted by the Australian Broadcasting Co., a group comprising Union Theatres, Ltd., Fuller's Theatres, Ltd., and J. Albert and Son, Ltd., music dealers, of Sydney. The tender provides for a three-year contract. Listeners will pay an annual licence fee of 24s., half of which will go to the programme contractors, who should thereby be assured under present conditions of an annual income of £240,000.

The contractor is required to furnish "programmes of general interest and of sufficient diversity to cater for the reasonable tastes of the community as a whole." Severe penalties are prescribed for non-compliance with the agreement, including the forfeiture of a bond of £5,000, wholly or in part, which the contractor is required to deposit.

The maintenance of stations and their equipment will be the responsibility of the Government, the sole duty of the contractor being to supply programmes.

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TRACKING "X's" BY FULTOGRAPH.

The Fultograph picture transmission system is to be put to a novel use at the Slough Radio Research Station for the purpose of recording atmospherics. By arrangement with the B.B.C. special Fultograph transmissions will be made from Daventry after the normal experimental periods, and these will be picked up at recording stations in various parts of Europe. The transmissions will not take the form of pictures; instead there will be sent out a series of straight lines, both horizontal and vertical, forming a grid or network. When an atmospheric occurs deformations of the straight lines will take place to an extent depending upon the intensity of the interference. It is hoped by this means that it may be possible to make records giving the most valuable data for research into the intensity, duration and origin of individual atmospherics. Since the drums of all receiving apparatus, wherever situated, are synchronised, it will be possible by comparing the results obtained in different places to determine the range at which an individual atmospheric can cause interference and the intensity of this interference in different localities.

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FARMERS AND THE MORSE CODE.

The Ministry of Agriculture has announced that farmers who own wireless sets of sufficient range and can read Morse may obtain later weather reports than those otherwise available. These reports are transmitted from twenty-two stations on 4,100 metres (C.W.).

Interviewed by a Press representative, Mr. John Garton, president of the National Farmers' Union, expressed the view that farmers were too busy to listen for weather reports several times a day. "As for Morse," he added, "farmers would not, in my opinion, take the trouble to learn it."

NEWS FROM THE CLUBS.

An Autumn Programme.

Slade Radio, Birmingham, is organising an interesting autumn programme which will include a trip to the Rugby wireless station on September 7th, direction finding tests on September 15th or 22nd, and a trip to the Olympia wireless exhibition on September 28th. Full details of the Society's activities may be obtained from the Hon. Secretary, 52, St. Thomas Road, Erdington, or Assistant Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

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D.F. in Hertfordshire.

Although ordinary club activities have been generally suspended during the summer months several societies have held very successful field days in which transmission and direction finding have played an important part.

Recently the Golders Green and Hendon Radio Society and Scientific Society in co-operation with four other clubs carried out a profitable and instructive direction finding scheme near South Mimms. The club's transmitter was taken to an unknown point and concealed in a barn about 20 yards away from a road. The station was staffed by four amateur transmitters who worked the key in relays. Nine direction finding groups in cars assembled near Watford at 10.30 a.m., after which hour they were allowed to begin to search in any direction. Transmissions began from the concealed station at 11 o'clock on a wavelength of 158 metres. The first group to discover the transmitter consisted of members of the Western District Radio Society who arrived at 12.55 p.m. The second, who arrived at 2.5 p.m., represented the Golders Green Society. Ten minutes later a third group made its appearance consisting of members of the North Middlesex and Golders Green Societies. The fourth and fifth represented respectively the Muswell Hill and Western Postal District Societies, the last named not completing the search till 4.4 p.m. Owing to non-compliance with certain conditions of the scheme and to technical faults, the second group to arrive was placed after the third, and the fourth group after the fifth. In a subsequent discussion the leading groups were congratulated on their skill.

Enquiries with regard to membership of the Golders Green and Hendon Radio Society should be addressed to the Hon. Secretary, Lt.-Col. H. A. Scarlett, D.S.O., 60, Pattison Road, N.W.2.

Atmospherics Spoil Transmissions.

Conversations over Essex and Kent were conducted during a recent field day held by the Southend and District Radio Society at Rochford, Essex. Although the weather was good, atmospherics interfered considerably with working between stations. The Society's transmitter, operating under the call sign G5QK, exchanged signals and speech on 1.7 megacycles with station 2ABK, operated by Messrs. Revell and Horsnell.

Hon. Secretary, Mr. F. J. Waller, Lynthorpe, Grange Gardens, Southend-on-Sea.

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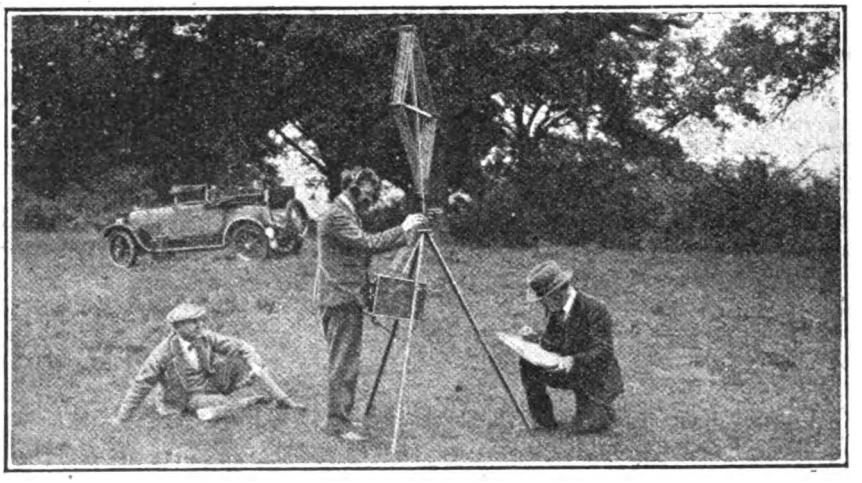
Public Address Tests.

The Newcastle-upon-Tyne Radio Society recently held its annual field day in the picturesque surroundings of the Allendale Valley, Northumberland. The Society was equipped with a Brown power public address equipment. The apparatus was installed at a suitable site on the hillside, the apparatus comprising a power loud speaker on tripod, a 4 stage, 9-valve amplifier, microphone and gramophone turntable. A high tension of 400 volts was obtained from the large capacity H.T. accumulators, weighing about a quarter of a ton. The last stage of the amplifier containing six L.S.5A valves in parallel gave an output of about 40 watts. Some interesting experiments were carried out in speech and music production over considerable distances. Not the least entertaining event of the day occurred after tea when the equipment was set up in the village square before a large crowd who listened to a recital of gramophone records.

The Society is busily preparing a syllabus for the coming session. Enquiries regarding membership will be welcomed by the Hon. Secretary, Mr. W. W. Pope, 7, Kimberley Gardens, Jesmond.



ON THE SCENT? A search party takes bearings during a recent concealed transmitter hunt organised by the Golders Green and Hendon Radio Society in conjunction with other societies in the London area.

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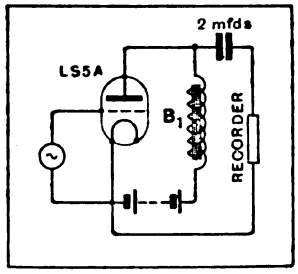
TRANSIENTS IN LOUD SPEAKERS AND AMPLIFIERS

The Important Effect of a Choke-filter Output.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

(*Concluded from page 121 of previous issue.*)

THE next case is that of choke-condenser output as used on an average set. The choke is a Ferranti B_1 (30 henrys) with 2 mfd. condenser. The recorded waveform of Fig. 8 is similar in nature to that for the 25/1 transformer, but there is a greater tendency for the current to hold up at the beginning. This shows that the system would reproduce low frequencies better than the 25/1 transformer. Since the circuit contains an inductance and a condenser it will oscillate when impulsed, unless the damping of the valve is adequate to prevent this. In



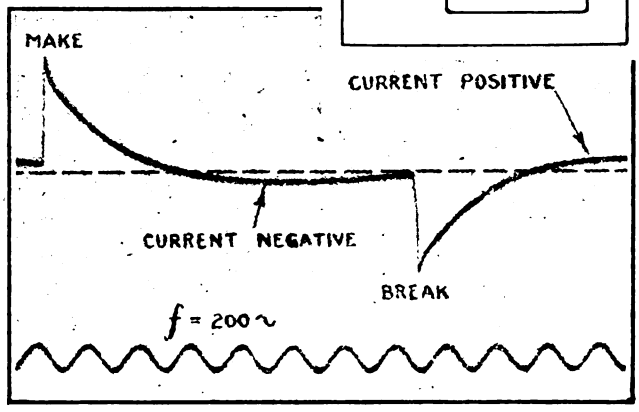


Fig. 8.—Record showing current in a choke-condenser output arrangement (choke, 40 henrys and condenser 2 mfd), when a rectangular waveform is applied to the grid of the valve.

Fig. 8 the current becomes negative and there is evidence of a damped oscillation of about 20 cycles, which, however, should not be serious since it is below the limit of audibility.[5] If the loud speaker response should be non-linear, harmonics will be created whose frequencies are (in the simplest case of non-linearity) 40, 60, 80 cycles, etc. Clearly the frequency of the oscillation can be reduced by increasing the capacity of the condenser. The influence of this is evident from Fig. 20 where the condenser is now 50 mfd. instead of 2 mfd. The waveform tends to be somewhat rectangular; actually the current falls away between make and break, this being concomitant with a natural oscillation, in the neighbourhood of 3 per second. I do not advocate a condenser of this magnitude for broadcast purposes. Any good it might do is quite undone by the loud speaker, as a glance at the transient picture gallery aforesaid will show.

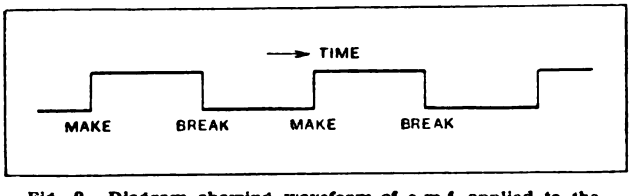
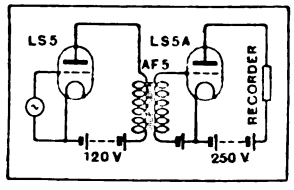


Fig. 9.—Diagram showing waveform of e.m.f. applied to the grid of the first valve of the combination under test.

The Case of L.F. Transformer Coupling.

Having mixed iron-cored apparatus with condensers, we pass back along the amplifier to a stage of inter-valve coupling where a transformer is used. Various cases present themselves. A normal case would be a Ferranti AF5 with an LS5 valve. The diagram for this case, in which the output is directly recorded, is exhibited in Fig. 10. There is a tendency to preserve a rectangular waveform, and undoubtedly this is due to the high primary inductance which enables the lower frequency components to be amplified. In Fig. 11



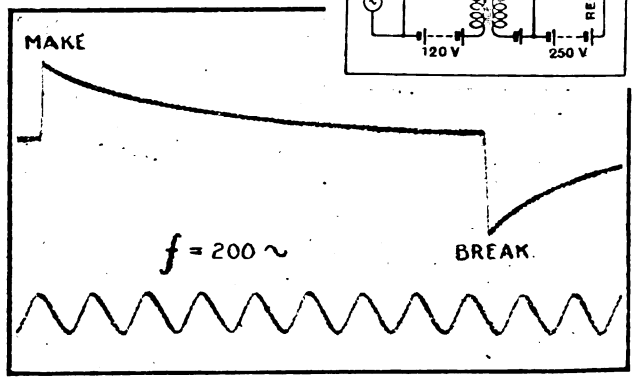


Fig. 10.—Waveform where the output is directly recorded.

the effect of using an LS5B valve having an internal resistance of five times the LS5 is illustrated. Clearly the tendency to rectangular waveform has substantially disappeared. This is due to the internal resistance of the valve curbing the low frequency components. The valve also reduces the higher frequency components—due to the self-capacity of the secondary—since the

[5] A smaller condenser might have rendered the system aperiodic.

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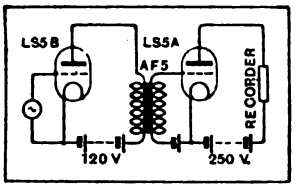
Transients in Loud Speakers and Amplifiers.—

initial rate of rise of current is less than that of Fig. 10, although it may be difficult to trace in the reproduced version of the record. Obviously the LS5B is not a suitable valve for the AF5.

Following the above trend of events, we can take an extreme case of considerable interest depicted in Fig. 12. Here we have an AF5 in combination with a DEH-610 valve of internal resistance 70,000 ohms. Instead of a rectangular waveform we have a highly damped oscillation whose frequency is substantially that of the transformer secondary, namely, 300 cycles per second. Although the self-capacity of the secondary winding is low, the inductance exceeds 1,000 henrys, and thus the natural frequency—which is reduced slightly due to the effect of the valve — is comparatively low. The combination of the AF5 and DEH610 would yield a 300 cycle note each time a severe transient arrived, but, of course, this might be camouflaged by the natural oscillations of the loud speaker. However, it should be quite evident that such a combination is definitely undesirable.



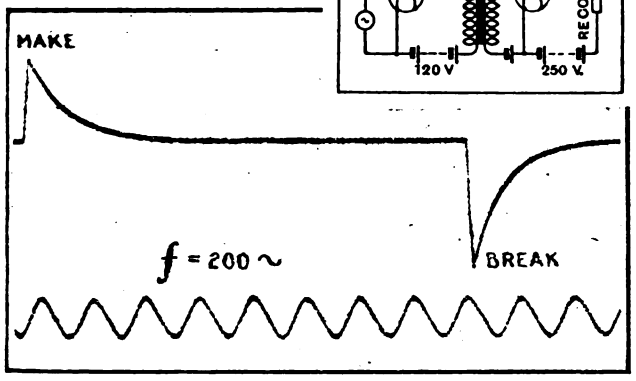
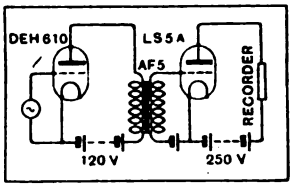


Fig. 11.—The effect of using a valve—the LS5B—having an internal resistance five times that of the LS5.



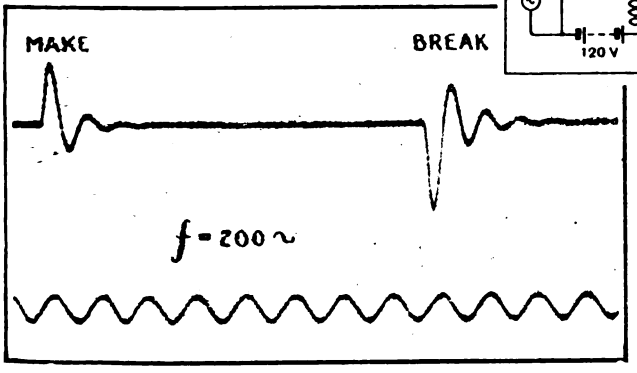


Fig. 12.—The case of an AF5 transformer preceded by a DEH610 valve. Instead of a rectangular waveform we have a damped oscillation.

The transformer oscillation is easily explained. A circuit equivalent to the valve and transformer is shown in Fig. 13. ρ represents the A.C. valve resistance, the inductance corresponds to the transformer primary, whilst the condenser is the capacity of the secondary multiplied by the square of the turns ratio, i.e., $3.5^2 = 12$. The LC circuit has a natural frequency of about 300 cycles, but when $\rho =$ 5,000 ohms, as with an LS5 valve, the damping is so heavy that no oscillation occurs, i.e., the system is aperiodic. As ρ is increased, a critical point is reached where the damping is inadequate and oscillation occurs. The higher the transformer ratio or the smaller the primary inductance, the lower must be the valve resistance to prevent oscillation. As a case in point we have in Fig. 14 the result of an Ideal 8/1 transformer with LS5B and DEH610 valves. With the LS5B valve there is a moderately damped oscillation of 1,000 cycles. In this case the primary inductance is only about 6.5 henrys, as against that of 100 henrys for the AF5, also the ratio is 8/1, as against 3.5/1. Therefore, apart from good response characteristics, one cannot indiscriminately use *any* valve with a transformer.

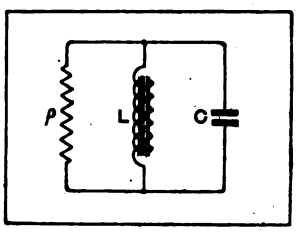


Fig. 13.—Circuit equivalent of valve and transformer.

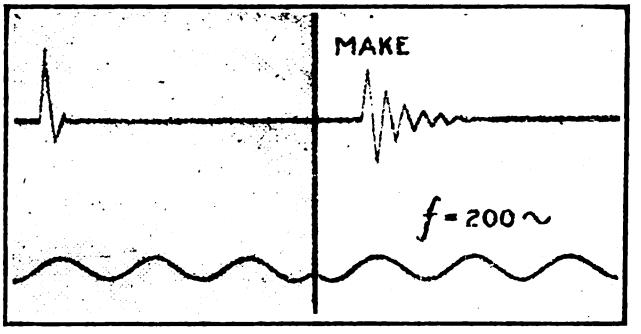


Fig. 14.—An Ideal 8 to 1 transformer preceded by an LS5B and a DEH610 valve.

Fig. 15 has been appended as a matter of interest, since it shows the rise and fall

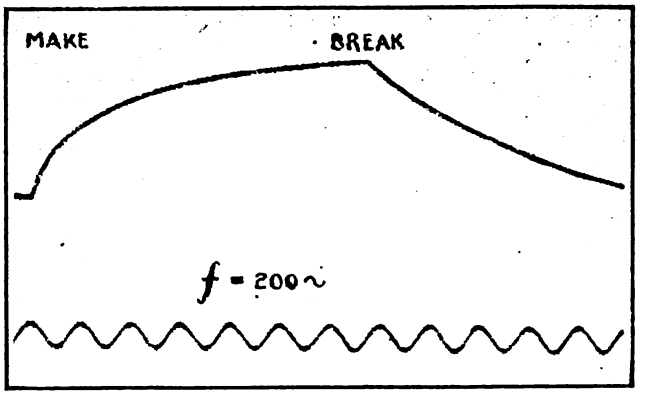


Fig. 15.—Showing the rise and fall of current in the primary of an AF5 transformer when used with an LS5 valve.

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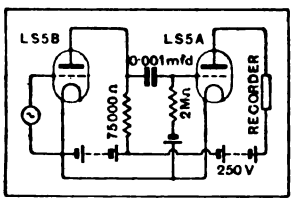
Transients in Loud Speakers and Amplifiers.—

of current in the primary of the AF5 transformer when used with an LS5 valve. The curves at make and break are similar to those obtained for any inductive circuit having series resistance. The secondary winding modifies the result slightly, due to the capacity,



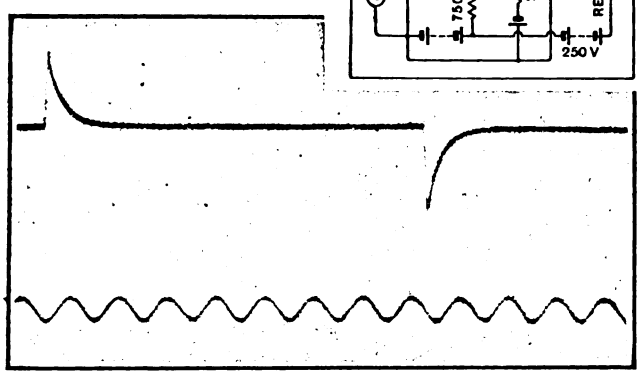
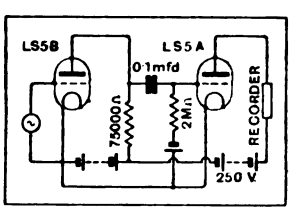


Fig. 16.—Resistance-capacity coupling where the coupling condenser is 0.001 mfd. The lower frequencies are lost.

as will be realised from an inspection of the equivalent circuit of Fig. 7.

Lastly we come to resistance-capacity coupling, the results for two cases being shown in Figs. 16, 17. In Fig. 16, where the coupling condenser is 0.001 mfd., the high frequencies are reproduced, since the initial rise is steep, but the rapid decay in current thereafter



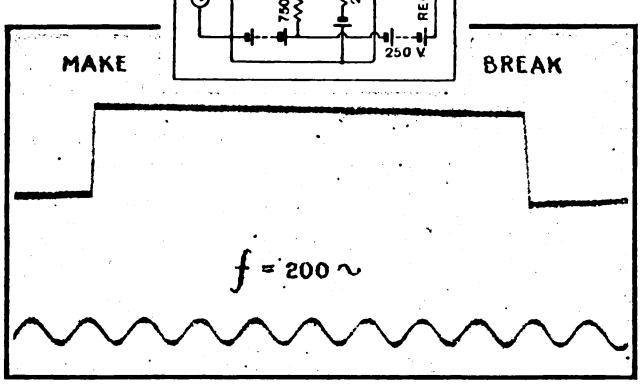
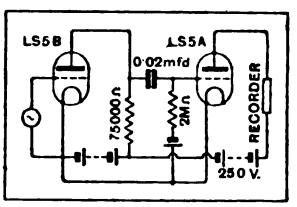


Fig. 17.—Resistance-capacity coupling using a 0.1 mfd. coupling condenser. In this case the rectangular waveform is very nearly reproduced.

indicates that the lower frequencies are not amplified. In other words, the coupling condenser is too small. The effect of a 0.1 mfd. coupling condenser is illustrated in Fig. 17, where the rectangular waveform is all but reproduced, the fall in the current between make and break being slight. The influence of a condenser of intermediate value, viz., 0.02 mfd., is depicted in Fig. 18, and this combination would be quite satisfactory for broadcast purposes. The influence on this arrangement of a 2 mfd. condenser-choke combination in the power valve stage is shown in Fig. 19. Clearly the profile is much less rectangular than that of Fig. 18, whilst the low frequency oscillation indicated in Fig. 8 is in evidence. By increasing the condenser to 50 mfd. the effect of the choke-condenser combination is substantially that of Fig. 18 where the output goes direct to the recorder. This is portrayed in Fig. 20. In comparing Figs. 18 and 20, due allowance must be made for the recorder speed being greater in the former case.



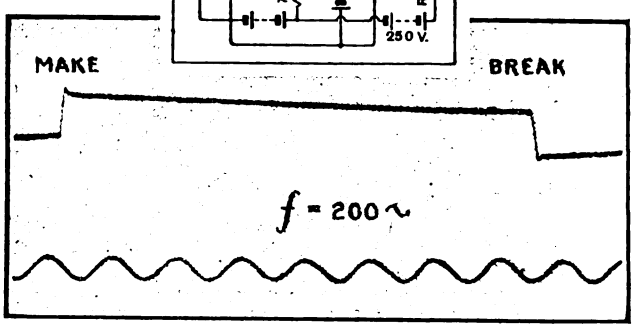
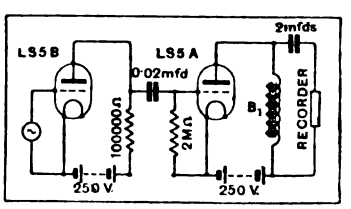


Fig. 18.—An intermediate value of coupling condenser, namely, 0.02 mfd., together with a two megohm leak, gives a satisfactory combination for broadcast reception.

So far as this investigation is concerned we find that amplifiers will superpose audible natural oscillations under the following conditions: (*a*) Transformer coupling with a valve having too high an internal resistance. (*b*) Choke-condenser output where the choke or the condenser is too small.

The value of the natural frequency $f = \frac{I}{2\pi} \times \left(\frac{I}{LC}\right)$ should be below audibility. The records also



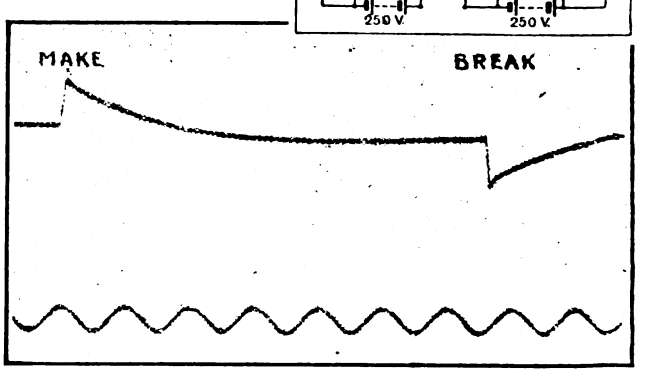


Fig. 19.—Where a choke filter output circuit is added to the amplifier shown in Fig. 18, the profile of the waveform is considerably less rectangular and there is evidence of low-frequency oscillation.

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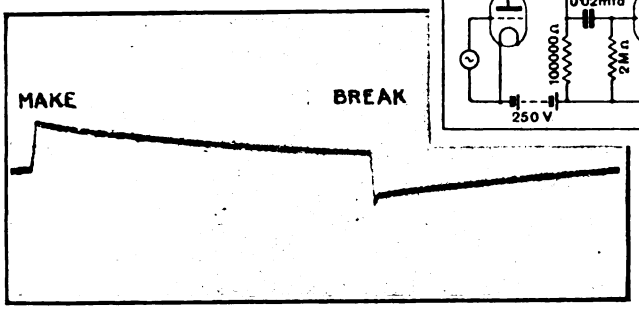
show very clearly whether the amplifier is capable of reproducing low frequencies with any degree of accuracy; a point of importance with moving coil speakers.

So far as a rectangular waveform is concerned the records show that



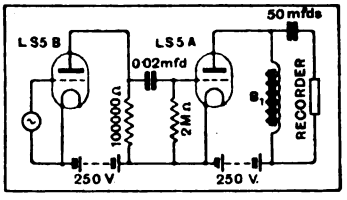


Fig. 20.—When a 50 mfd. output condenser is used the waveform is again substantially rectangular.

it is possible to design good amplifiers to work between certain frequencies, but with loud speakers the output, unfortunately, is distorted to a degree which is serious.

Low-frequency Amplifier Defects Masked.

So long as transients[6] are accompanied by the natural oscillations of a loud speaker (see Fig. 1) the latent defects of a modern L.F. amplifier will be difficult to detect.

It is only by conducting tests on the above lines that it is possible to ascertain the extent and characteristics of the distortion due to amplifiers or loud speakers. Having located the source of trouble one can take steps to avoid it by careful design.

A great deal has been written concerning the relative merits of transformer and resistance coupling; comparisons have been made with a sine-wave input, and little attention has hitherto been given to the effect of rectangular waveforms. The records clearly show that, having selected an L.F. valve, there are limitations in the choice of the coupling components.

[6] For additional information see *Proc. Roy. Soc. A.*, Vol. 122, p. 604, 1929, also *Phil. Mag.*, Vol. 7, Supplement, p. 1011, June, 1929.

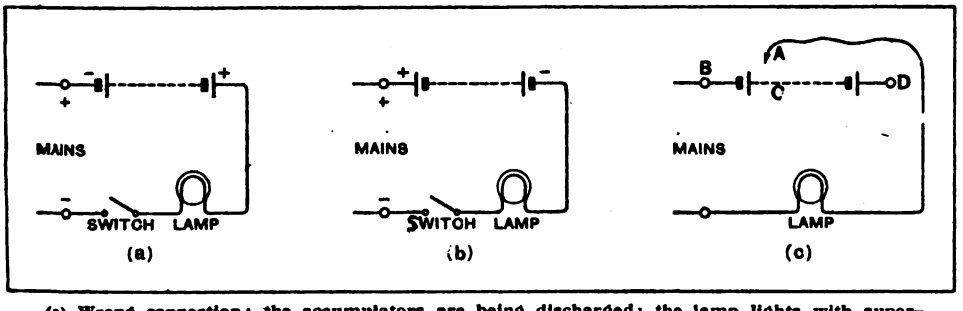
CHARGING HIGH-TENSION ACCUMULATORS.

The Question of Polarity.

IN charging high-tension accumulators from D.C. mains, it is usual to employ a lamp as a resistance to limit the current to that suitable for charging. It is not generally realised that this lamp can also be used for finding the polarity of the mains, and so ensuring that the accumulators really are charged, and not discharged by being connected wrongly.

A glance at (*a*) in the figure will show that if the negative end of the accumulator is connected to the positive pole of the mains, the voltage of mains and accumulator are added, giving a total voltage higher than that of the mains alone. If the circuit is now closed through the lamp, it will light with a brilliancy greater than normal. The current supplied to it is then partly derived from the mains, and partly from the accumulators, which are thus being discharged and not charged.

Conversely, if the negative end of the accumulator is joined to the negative pole of the mains, as in (*b*), the available voltage from the joint source will be equal to the difference, instead of to the sum, of their individual voltages, so that on closing the circuit the lamp will light with less than normal brilliance. In these conditions the accumulators are being charged, which is what is wanted.



(a) Wrong connection: the accumulators are being discharged; the lamp lights with supernormal brilliance. (b) Correct connection: the accumulators are being charged: the lamp lights but dimly. (c) Before joining A to D, touch it on B and C to check polarity.

A Useful Check.

It will have been noticed that when the lamp is brighter than normal, the mains are wrongly connected, and when it is dimmer the connections are correct. Immediate comparisons of the lamp's brightness can be made by the arrangement shown at (*c*); the lead A is first touched on the terminal at B, when the lamp will light normally, and then at C, some twenty or thirty volts from B. If the lamp is now dimmer than before, A may be connected to D and charging commenced in earnest. If, on the other hand, the lamp is brighter when A is at C than when it is at B, the plug by which connection is made to the mains must be reversed in its socket before joining A to D.

To check polarity in this way before screwing the last wire under its terminal takes only a few seconds, and the assurance of correct connection that it gives is sufficiently definite to make mistakes practically impossible, and is obviously worth while.

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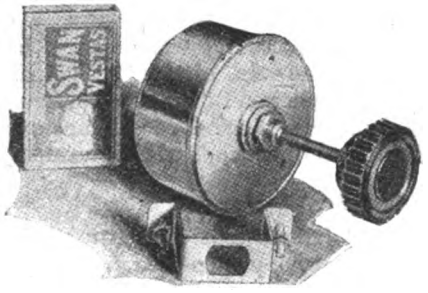
A Review of the Latest Products of the Manufacturers.

SUPER-POWER CLAROSTAT.

The super-power Clarostat is a heavy-duty variable resistance functioning on the compression principle, and is rated to dissipate 250 watts. It is available in three resistance values, 0.25 to 10 ohms, 25 to 500 ohms, and 100 to 100,000 ohms. The lowest value is particularly suitable for controlling the filament current to a bank of large super-power output valves in public address equipment, or similar apparatus. For the higher values such functions as motor regulation, fine control of primary current in small-power transformers and many like uses, will readily suggest themselves to the radio engineer.



Super-power Clarostat with mounting bracket. The size can be gauged by comparison with a matchbox.

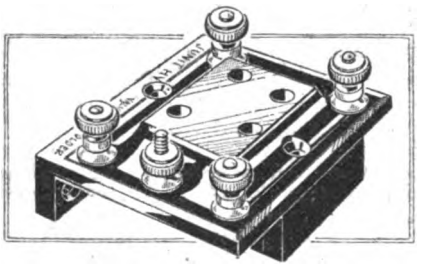
The sample sent in for test had a measured maximum resistance of 1,000 ohms, and a minimum value of 30 ohms. A slightly lower minimum than this could be obtained by applying more force than was considered desirable to the adjusting spindle. Further measurements were made after the device had been in use as a motor-generator input control (220 volts, about 50 watts).

Immediately after removing from the circuit and while the resistor was too hot for comfortable handling, the resistance values were found to be 12.5 ohms minimum and 1,100 ohms maximum. When cooled, further measurements showed that the minimum value had changed to 15 ohms, while the maximum had increased to about 3,000 ohms. These values did not change to any appreciable extent after further periods of use.

These resistances are supplied by Messrs. Claud Lyons, Ltd., 75, Old Hall Street, Liverpool, and the price has been fixed at 30s.

"JUNIT" VALVE HOLDER AND TERMINAL MOUNT.

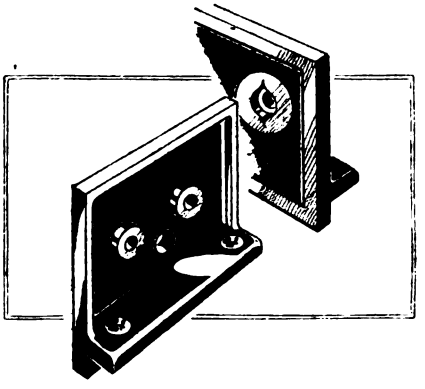
The "Junit" valve holder has been designed for horizontal or vertical mounting, and is provided also with a spare terminal which can be used as an anchorage for a wander lead, such as would be



"Junit" H.V. valve holder.

required for a pentode valve. It is essentially a universal valve holder, since it can be used for screen-grid valves, triodes, or pentodes. The body consists of a clean moulding with the valve sockets sunk below the top as a safety measure. The model illustrated is the type H.V., and is priced at 1s. 9d.

Another very useful accessory is a small moulded terminal strip measuring 2½in. × 2in. high, with holes for two terminals and leads. It is moulded in black bake-



"Junit" moulded terminal strip.

lite, and is provided with a flange on the inside face for fixing to the baseboard. The visible face is, therefore, free from unsightly screw heads. The makers are the Junit Manufacturing Co., Ltd., 2, Ravenscourt Square, London, W.6, and the price is 1s. 3d. a pair.

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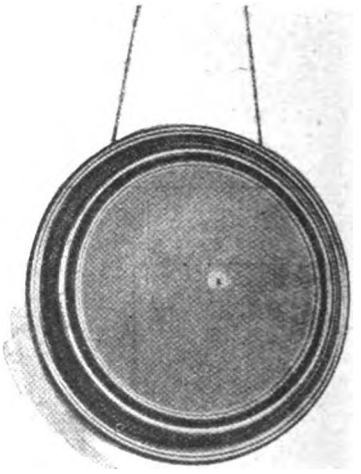
AMPLION "GUINEA CONE."

This is a redesigned, and incidentally an improved, version of the Amplion A.C.2 model "hanging type" cone loud speaker which we reviewed in our issue of February 8th, 1928. As its name implies, the price is one guinea only, but the performance is such that it could well be classified among those costing considerably more. The reproduction is clear, crisp, and free from objectionable resonances, although the movement used is of the single-acting reed type working into a fabric cone 9½in. in diameter.

A small power valve with about 150 volts H.T. will deliver ample power to operate the loud speaker at sufficient volume to fill a room of average size comfortably. Its sensitivity to small electrical inputs is surprisingly good.



Amplion "Guinea Cone" loud speaker for wall suspension.

Like its predecessor, it is intended to be hung from the picture rail, and a silk cord is provided for this purpose. The protecting rim and support for the unit is moulded in one piece from mottled brown material, and the cone is finished appropriately. The design and finish are such as to be in harmony with most furnishing schemes. The makers are Messrs. Graham Amplion, Ltd., 26, Savile Row, Regent Street, London, W.1.

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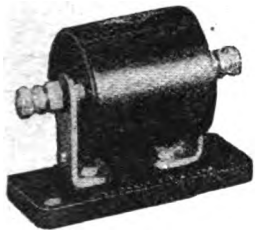
BOWYER-LOWE LONG-RANGE H.F. CHOKE.

The outstanding feature of this component is the excellence of the electrical characteristics having regard to its small dimensions. In this respect the design



The Bowyer-Lowe long-range H.F. choke; D.C. resistance 400 ohms.

can be regarded as ideal, as the space available in the vicinity of the detector valve in the average set is generally limited. A choke of small dimensions permits a more logical arrangement of parts and wiring, and also reduces the possibility of coupling with other parts of the circuit.

The makers claim that the choke is suitable for wavelengths from 7½ to 4,000 metres, and the measurements we have made indicate that this claim is justified. Even with the small external capacity associated with the measuring apparatus, the resonant wavelength is 2,800 metres, and under working conditions in a receiving circuit there is no reason to doubt that the resonance would approach 4,000 metres. With regard to the ultra-short waves, it is a matter of experience that chokes which have a long-wave resonance at resonance is above the average. Impedance values at other important wavelengths are as follows:—

Wavelength (metres).	Impedance (ohms).
200	8,500
500	27,000
1,500	188,000

The wire is wound in a slotted ebonite former only 1⅛in. diameter and 1⅞in. long. A small ebonite base is provided for baseboard mounting, but the choke unit can be easily detached and suspended in the wiring of the set if desired.

The price is 7s., and the makers are The Bowyer-Lowe Co., Ltd., Letchworth, Herts.

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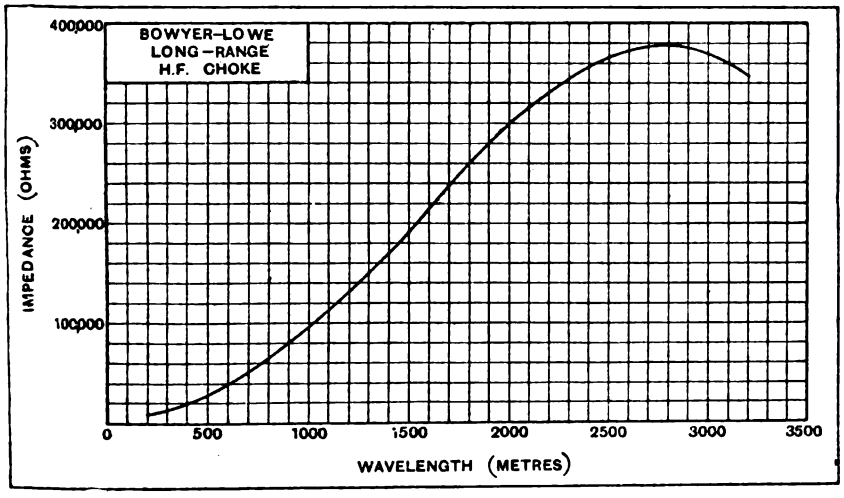
BAWTREE HIGH TENSION ACCUMULATOR.

These batteries are supplied, normally, in units consisting of 12 cells and giving 24 volts. They are sent out with the plates unpasted, and before putting into use the positive plates must be filled with a paste made up from red lead and weak sulphuric acid, while the negative plates require filling with a paste prepared from litharge and acid.

The electrolyte consists of sulphuric acid (accumulator acid) diluted with distilled water to a strength of 1,150. The initial charge should be for 6 hours at 0.1 amp., and subsequent charges for 8 hours at the same rate. The full capacity will not be obtained until the battery has been charged and discharged a number of times.

These batteries are supplied by Messrs. A. E. Bawtree, F.R.P.S., 20, Manor Park Road, Sutton, Surrey, and the price is 3d. per volt in 24-volt units. Smaller units can be supplied at an additional charge of 6d. per unit, a 10-volt unit costing 3s.

Spare plates and glass tubes cost 6d. each and spare ebonite separators 3d. each. It will thus be seen that the replacement of a faulty cell will be an easy matter.



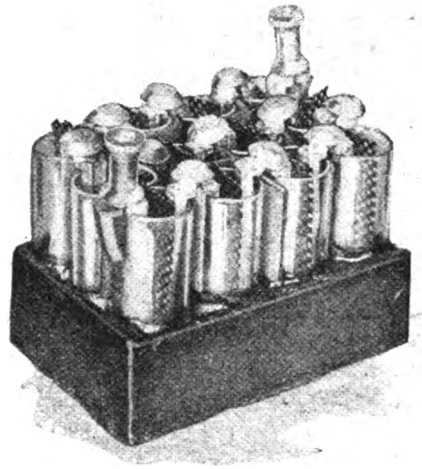
Impedance curve of Bowyer-Lowe long-range H.F. choke; external capacity 8 micro-mfd.

and a comparatively flat impedance curve give results equal to and in many cases better than specially designed short-wave chokes. The impedance curves of the latter are "peaky," and the impedance at the foot of the curve is often no greater than that of the long-wave choke at the same wavelength.

The Bowyer-Lowe choke is free from subsidiary resonances, and the impedance

"B.A.T." POWER TOGGLE SWITCHES.

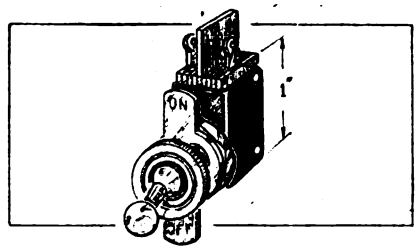
These miniature switches—they measure 1¼in. × ½in. × ⅝in. behind panel—are available in two types—a single-circuit and a double-circuit make-and-break. The single-circuit switch costs 2s. 5d., and the double-pole type is sold at 3s. 9d. In the "on" position the "live" contacts are bridged by a roller



Bawtree 24-volt H.T. accumulator unit.

which is held firmly in position by a helical spring. The two positions are positively defined, the lever moving into position with a reassuring snap.

All "live" parts are adequately protected, the lever, fixing bush and exposed metal work being insulated from the electrical contacts. Strips of paxolin are used for insulating purposes, the various pieces being shaped to form a hollow chamber which the roller contact operates.



"B.A.T." quick make-and-break miniature switch with one-hole fixing bush.

The external contact tags are separated by an extension of one of the paxolin strips and on each side of this there is a small ventilating hole giving access for air to the centre chamber.

The area of the contacting surfaces appears to be on the small side for a switch rated to carry 3 amps., at 250 volts; however, they functioned quite well on test and did not give any cause to justify doubt as to their ability to handle this wattage.

Their miniature size renders them ideal for use in portable sets, and the high standard of insulation achieved justifies their use in all types of mains equipment.

These switches are of American origin and are supplied in this country by Messrs Claud Lyons, Ltd., 75, Old Hall Street, Liverpool.

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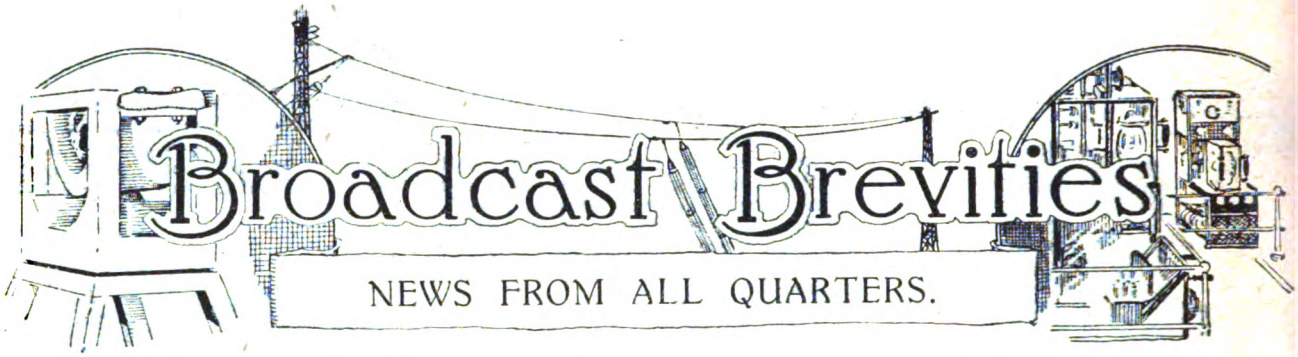

Regional Stage Fright ?—Ca' Canny at Brookman's Park.—B.B.C. and Sunday Programmes.

Peculiar Policy at Brookman's Park.

Since the B.B.C. will find time to carry out some radiation experiments from Brookman's Park before the service transmissions begin, it seems pertinent to ask why the "fade in" principle is to be adopted at all. We have been told that the change-over from the Oxford Street transmitter to the London Regional will be effected gradually, beginning with late dance music, and that each day will see a slight increase in the period of transmission from the new station until the existing 2LO is finally superseded.

For my part, I fail to see what object this ca' canny policy will achieve.

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Why Prolong the Agony?

Possibly the B.B.C. is suffering from a sort of H.F. stage fright, fearing that those listeners who have no selective H.F. stages will run amok if suddenly faced with 25 kilowatts where there were only 3 kilowatts before.

The B.B.C. should take the risk. No good purpose will be served by prolonging the agony; there are no compensations in having teeth drawn slowly.

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Period of Chastening.

Again, Savoy Hill has spent many weeks in telling the trade how to instruct customers in the alteration of their sets in preparation for more powerful signals. In many cases the listener has been advised to shorten his aerial.

The conscientious listener who has followed this advice will undergo a period of chastening while the transition is taking place. Half his evening will be spent in lengthening his aerial to pick up Oxford Street while the other half will be occupied in accommodating it to Brookman's Park.

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Why Not an Inaugural Programme?

The best plan that the B.B.C. could adopt would be to fix a definite date—say September 14th—for the opening transmission from London Regional. The occasion—the inauguration of the Regional Scheme—merits a special programme.

As a safeguard against accidents, the Oxford Street transmitter could be retained for a month or two, but it must be remembered that Brookman's Park is not entitled to a long experimental period. 5GB has been the Regional Experimental station, as listeners to that station know to their cost!

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A Sunday Innovation?

For a semi-Government organisation, the B.B.C. shows an astonishing and pleasing lack of inertia. All things considered, Savoy Hill is surprisingly responsive to listeners' demands in all except one respect. In accordance with the "spirit of the age," quite a number of people would like the Sunday programmes secularised to a greater degree than at present, but the B.B.C. has preserved a rigidity of outlook on this subject which seems to have awed even the profanest.

Now comes the startling possibility that on a Sunday in September the afternoon transmissions from all stations except 5GB may be devoted to a running commentary on the international air race to be flown over the Solent for the Schneider Trophy.

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An International Event.

It is understood that this event will probably take place on September 7th, 8th or 9th, depending upon weather conditions. I hear that when the running commentary was first arranged it was decided that the broadcast would not take place if the race occurred on the 8th (Sunday). In view of the international importance of the race, however, official opinion has relented, so it is by no means unlikely that, for once, the Sunday programme may contain more race than grace.

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An Empire Broadcast.

The B.B.C. microphone will be situated on the roof of the Ryde Pier Pavilion a few yards from the judge's stand. It is expected that it will be possible to receive and broadcast the lap positions and the final results within a few seconds of the judge's decision. There are ten competitors in the race, which covers seven laps of approximately 31 miles.

The lines in use for broadcasting will include the new cable beneath the Solent from Ryde to Portsmouth.

The transmission will also go out from 5SW, Chelmsford.

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Music at Meals.

Diners-out seem to have a legitimate grouse against the B.B.C. in the matter of restaurant music. It is complained that since the broadcasting of hotel orchestras began, the standard of musical performance has improved to such ar extent as to interfere with the more serious business of mastication and digestion, the unfortunate diner being unable to concentrate on his victuals. The B.B.C. should supply soda bicarb.

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Radio Drama.

The B.B.C. expects as big a success for the play, "One Day More," by Joseph Conrad, when it is broadcast from 5GB on Monday next, August 19th, as the distinguished author's "Lord Jim" met with when it was adapted for broadcasting by Cecil Lewis some two years ago. "One Day More" is one of the only two plays which Conrad wrote, though he also dramatised his novel, "The Secret Agent."

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A Revival.

A noteworthy revival of next month will be that queer drama of life in Suburbia, "Squirrel's Cage." It is down for performance from 2LO on September 12th.

FUTURE FEATURES.

London and Daventry.

AUGUST 20TH.—Famous Northern Resorts Programme from Blackpool.
AUGUST 22ND.—A Feature Programme.
AUGUST 23RD.—The Canterbury Festival of Music and Drama—A Symphony Concert.
AUGUST 24TH. — "The Mulligatawny Medallion," a light play.

Daventry Experimental (5GB).

AUGUST 18TH.—An Orchestral Concert.
AUGUST 20TH.—Programme of Popular Chorus Songs.
AUGUST 22ND.—A Vaudeville Programme.
AUGUST 24TH.—Queen's Hall Promenade Concert.

Cardiff.

AUGUST 18TH.—Coleridge-Taylor Programme.

Manchester.

AUGUST 21ST.—Commentary on the Rydal Sheep Dog Trials.

Newcastle.

AUGUST 20TH.—The Electric Sparks Concert Party.

Glasgow.

AUGUST 24TH.—"What Ho! America," a revue.

Aberdeen.

AUGUST 21ST.—A Scottish Concert.

Belfast.

AUGUST 22ND.—"Faust" (Gounod).

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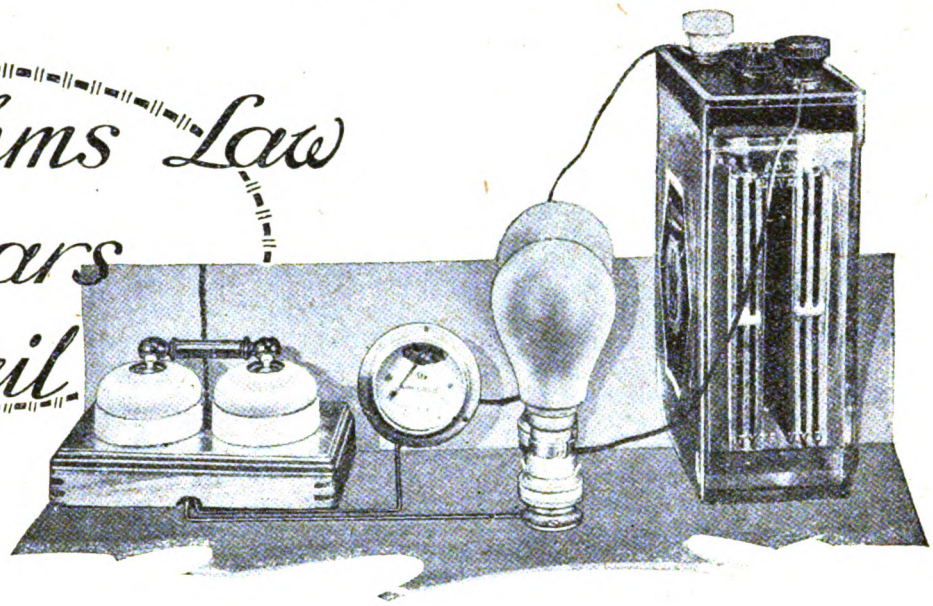
When Ohms Law Appears To Fail



By
N. P. VINCER-MINTER.

Seeming Inconsistencies Explained.

IN order to appreciate the points to be raised in this article, it is obviously necessary for the reader to be acquainted with Ohm's law itself, and although the writer has dealt with it at some length in previous issues of this journal he feels it desirable to recapitulate briefly the principles underlying this great natural law, one of the greatest, in fact, that has ever been discovered and promulgated by man, since it is the foundation stone upon which all the various branches of electrical engineering, including radiotelephony, are based.

Ohm's law is best expressed as a simple equation, namely, $I = \frac{E}{R}$, where I represents the current measured in amperes, E the electrical pressure measured in volts, and R the electrical resistance measured in ohms. From this equation it is obvious that, provided we know any two of the three measurements under consideration, it is but a matter of elementary calculation to discover the third; in other words, the equations $R = \frac{E}{I}$ and $E = IR$ are equally true.

Battery Charging Problems.

Now there is one other thing we require to know, and that is how to discover and express the power being dissipated in any electrical circuit. This is done by multiplying the current and voltage, which gives us a figure for power the unit of which is the watt. It will now be seen that if any three of the four quantities which we have just been discussing are known, the fourth is easily found.

We can now pass on to the consideration of instances where Ohm's law appears to fail. It never actually fails, of course, although the writer is aware that there are many who, through lack of clear thinking, allege that it does fail in certain cases.

The first instance of apparent failure which the amateur is likely to encounter is in the charging of accumulators. We will assume that we have 250-volt D.C. mains, and wish to charge a small 2-volt accumulator the charging rate of which is 0.25 amperes. Now it is well known that the internal resistance of an accumulator cell in good condition is so low that it is virtually negligible. It is therefore obvious from Ohm's law that if the cell is connected directly to the mains there will be an enormous rush of current, and we must put a series resistance in circuit in order to limit the current to 0.25 amperes, which we have already assumed to be the normal charging rate of the accumulator. We will in this case ignore the back voltage of 2 due to the accumulator in order to simplify matters. A moment's work with Ohm's law shows us that a resistance of 1,000 ohms is required in circuit in order to limit the flow of current to 0.25 amperes. Now it is quite easy to obtain a reliable variable resistance of this value which is fully capable of carrying a much larger current than that stated without heating up. We can, however, choose one of the 250-volt 60-watt lamps which we have in the house, since it is clear from our knowledge of Ohm's law that its resistance *must* be 1,000 ohms, and if we put a reliable ammeter in circuit the reading will be found to be 0.25 ampères.

The Carborundum Crystal.

Let us suppose that, for some reason, we desire to halve the charging rate. The obvious idea of putting an additional lamp of the same rating as the original lamp in series in the circuit, as shown in Fig. (a), occurs to us, for we know by Ohm's law that doubling the resistance in circuit will halve the charging current. The lamps will now be burning dimly, as

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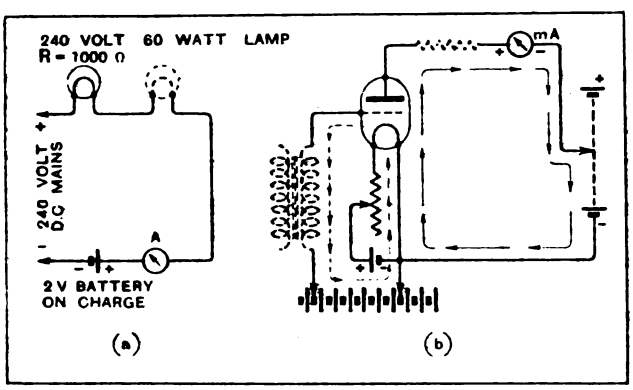
When Ohm's Law Appears to Fail.—

the voltage across each will be only half the rated value, or, to put it another way, only half the current required to cause normal filament brilliance will be flowing. If we consult our ammeter, however, we shall find that our actual current is either considerably less than half or considerably more, according to whether our lamp is of the carbon or metal filament variety. It would appear, then, that Ohm's law has failed. This is, however, quite fallacious. What, then, has happened? Simply that the resistance of the lamp filament has changed. The explanation is that the resistance of a lamp filament changes with the temperature, and the resultant effect is the same as if we had been using a variable wire-wound resistance, and had failed to adjust it so as to include twice the amount of wire in circuit when desiring to halve the current.

Another thing to consider is the peculiar behaviour of the ordinary carborundum crystal. If a voltage be applied across this crystal, and gradually raised, a proportionately increasing current will flow until a certain critical point is reached, at which it accelerates more rapidly than the voltage. Apparently Ohm's law has failed; actually, however, the resistance of the crystal has suddenly become lowered.



In (a) is shown a simple battery charging circuit, while (b) shows a simple valve testing circuit. In the latter case it should be noted that the arrow shown in dotted lines indicates the direction that grid current flows if positive bias is applied.

The carborundum crystal is not alone in its peculiar properties of changing its resistance under certain conditions. Selenium, for example, changes its resistance under the influence of light, and many substances change their resistance under various influences, such as heat, mechanical pressure, etc. The modern photo-electric cell, of which the selenium cell was the precursor, possesses the property of altering its electrical resistance in accordance with the degree of light thrown upon it, and it is this property that has rendered possible the advent of talking films and such success in television as has already been obtained.

Ohm's Law and the Thermionic Valve.

We can now pass on to a point which concerns us most, namely, the apparently anarchic attitude of the ordinary three-electrode valve towards Ohm's law. In order to discuss this matter we will consider a valve which has a milliammeter in its plate circuit and which is provided with the usual H.T., L.T., and grid bias batteries. When all is connected up correctly, a steady current will, of course, pass from the valve filament across to plate through the milliammeter and H.T. battery back to filament, and then across to plate once more as indicated in Fig. (b) by the full arrows. We can ignore completely the actual filament heating circuit, which may be considered as a simple local circuit which does not here concern us.

Valve Resistance Altered by Grid Bias.

Now if we try the experiment of raising and lowering the value of voltage on the grid we shall at once notice that the plate milliammeter is varying in its readings in sympathy with the varying voltages we put on the grid. At first sight it would appear that Ohm's law has failed us altogether, for the current in the filament-plate-H.T. battery circuit (usually known as the plate circuit) is changing without our altering in any way the H.T. battery voltage or the value of any resistance in the circuit, such as an anode resistance, which we could, if we so desired, put in series with the milliammeter. Let it be said at once that if the plate circuit *could* be changed without any alterations being made to the voltage or resistance of the circuit, then would our faith in Ohm have been in vain. Actually, however, the cause of the varying plate current is the varying of the valve resistance.

It must be remembered that the grid in the valve is mounted directly in the path of the " electron stream " (a synonym for electric current) passing from filament to grid, and if we bias the grid negatively, or, in other words, force electrons from the grid battery on to the grid, they repel, to a certain extent, the electrons leaving the filament *en route* for the plate. The greater the negative bias, therefore, the less the number of electrons reaching the plate, and *vice versa*. The grid then merely acts as a variable valve resistance.

If we withdraw electrons from the grid by biasing it positively, we shall not only get a heavy plate current, but shall start a new thing, namely, grid current, which consists of electrons leaving the filament passing to the grid and then passing *via* the grid leak or transformer secondary to the negative end of our valve filament. An interesting point to notice here is that when grid current flows, it is in the direction of the dotted arrows, and so *tends* to charge the grid battery, and if we used a small accumulator for our grid battery it would actually charge it if the current were large enough to produce any definite chemical effect. The foregoing remark has somewhat of a Hibernian flavour, but is nevertheless true. Screen-grid valves and pentodes are, of course, equally as amenable to Ohm's law as the triode.

There are many other points in connection with the valve and Ohm's law upon which space forbids us to dwell. Similar considerations also forbid any discussion of Ohm's law and alternating current, and the writer can only state that in alternating current work, be it of the power variety, the " L.F. amplifier " variety, or the high-frequency variety, Ohm's law is still impregnable; there are many traps for the unwary who think they have found its Achilles heel.

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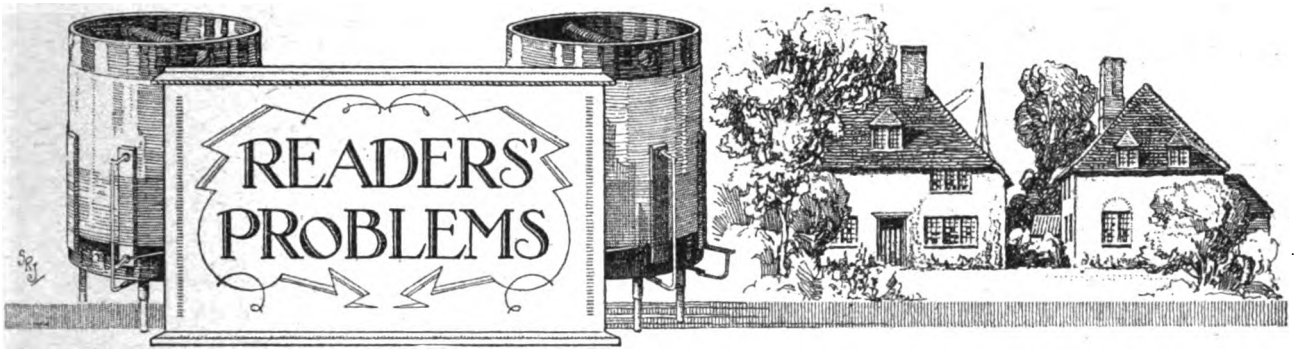

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below: these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Grid Circuit Decoupling Resistance.

I notice that in one or two receivers described in The Wireless World, *decoupling resistances and by-pass condensers are included in the grid circuit, particularly of an anode bend detector. Can you give me an idea as to the best resistance value to use, as there seems to be no general agreement on this point?* L. W. E.

The addition of a decoupling scheme to the detector-grid circuit is likely to be of some advantage when this valve is preceded by a highly efficient H.F. amplifier, and when bias is obtained from an unscreened battery common to other valves. As to the value of the resistance, a good deal depends on whether it is considered necessary to take precautions against L.F. interaction, as well as to restrict the flow of H.F. currents. Up to a point, the value is not critical, but the use of too large a resistance is apt to accentuate troubles brought about by the intermittent flow of grid current—which may sometimes take place in the best regulated set. Grid-leak type resistances are handy for this purpose, and we suggest a value of something between 10,000 ohms and 50,000 ohms.

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Audio-Transformer Coupling.

In almost every case, designers of sets with S.G. high-frequency valves make a point of the fact that a compromise between the requirements of selectivity, sensitivity and amplification can be made by suitably adjusting the number of primary turns of the tuned intervalve transformer. My own set is coupled by the tuned anode method. Is there any easy and simple way of effecting similar adjustments without radical alteration to the design? S. C. G.

Practically speaking, the advantages offered in this direction by double-wound transformers can be obtained in cases where tuned anode couplings are used by converting the coil into an auto-transformer.

The method of procedure will be made clear to you by a consideration of Fig. 1, in which the conventional connection between valve anode and coil is shown by a full line. When it is desired to improve selectivity, or to reduce amplification so that stability may be obtained, this connection is transferred to a tapping on the winding, as indicated by the dotted line. As this tapping is moved towards the end of the coil in connection with H.T.+, there will be progressive improvement in selectivity and, generally, a falling-off in amplification (unless the valve has an impedance well below the average).

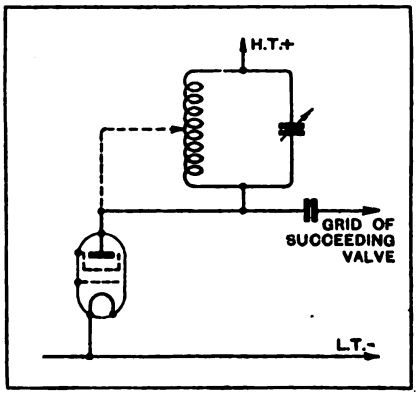

Fig. 1.—Illustrating a method of improving the selectivity of a "tuned anode" H.F. coupling.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

oooo

The "Everyman Four" and Gramophone Reproduction.

I am told that there is a very simple method of connecting a pick-up to an "Everyman Four" without the need of any alterations whatsoever. Will you please describe it? V. L.

Without a doubt, the simplest way of making this addition is to join the pick-up directly across the grid leak associated with the first L.F. valve. Of course, the H.F. valve filament, will be turned off, and, strictly speaking, provision should be made for extinguishing the detector filament in some way—a separate rheostat for it is not included in the original design.

As you will have gathered from recent articles on the subject, the majority of modern pick-ups give a sufficient output to operate with a two-stage L.F. amplifier—into which, in effect, the set is converted by fitting a pick-up in the manner described.

oooo

H.F. Input Control.

A good deal has been written on the subject of pre-detection volume control, but I have seen no mention of the device I am at present using. This consists of a variable resistance of 250,000 ohms maximum value, connected directly across the aerial-grid coil. Do you consider that this scheme has any serious technical disadvantage? F. S. G.

In your locality, almost midway between two main stations, we would expect this simple volume control to work quite well, because selectivity cannot be a very serious problem to you. The scheme has but a limited field of usefulness for the reason that the selectivity of a tuned circuit is greatly reduced when a comparatively low ohmic resistance is connected across it, and it is invariably considered better to use a potentiometer device in which the tuned circuit is shunted by a high resistance, the desired signal voltage being picked up by means of a variable contact.

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Eddy Current Coupling.

A good deal of attention has been paid of late to the question of screening in H.F. amplifiers. If we assume that plate and grid circuits, with their associated components, are completely enclosed in metallic boxes, is there any possibility of unwanted coupling between the coils? C. F. W.

Unfortunately, even the most complete screening does not preclude all possibility of undesirable couplings through magnetic interaction, although in almost all cases it reduces it to an almost negligible value. In amplifiers of the highest efficiency, in which maximum stage gain is aimed at, a certain amount of trouble is sometimes experienced through what is known as "eddy current coupling." This can generally be overcome by suitable disposition of the coils, and by careful choice of the earthing points on the metallic screens, although it might sometimes be necessary to go to the length of using double screening.

oooo

Anode Detector and Pentode.

The suggestion has been made that a pentode output valve is not altogether suitable for use immediately after an anode bend detector when these two valves are coupled by an L.F. transformer. Do you consider that there is any basic objection to this scheme? I may add that I have tried it with, apparently, very pleasing results. M. C. M.

There is no real reason why this arrangement should not work well, but in order to get the best results from it, certain precautions should be observed. The main disability of the scheme is associated with the fact that the pentode cannot handle a very large input voltage, while the anode detector preceding it works at its best under these conditions. This being so, it is not hard to see that, when the detector is working at its best, there is a serious risk of overloading the pentode, particularly if L.F. voltage is "stepped up" by a coupling transformer, and accordingly one is tempted to operate the detector incorrectly—from the point of view of quality—by reducing the H.F. input to it. The need for doing this can be avoided by shunting the primary of the transformer with a variable resistance, so that excess magnification can be thrown away when necessary.

oooo

Complicated Switching.

The H.F. stage of my set is transformer-coupled, and waveband switching is included, the method adopted being that in which low-potential ends of primaries and secondaries are connected together, while appropriate connections of the other ends of these windings are made by the blades of a double-pole switch. Long- and short-wave couplings are separate components, mounted with the coil axes at right angles. I now propose to add capacity-controlled reaction, winding the necessary extra coil on each transformer. Will you please show me how a four-pole two-way switch, already in my possession, may be used for waveband changing? N. G. S.

A satisfactory method of switching, applicable to the arrangement you specify, is shown in Fig. 2. We fear that it looks complicated, but it is hardly possible to simplify matters without introducing some modification to your proposed scheme. In any case, you will find it easy enough to trace out the connections, which are quite straightforward.

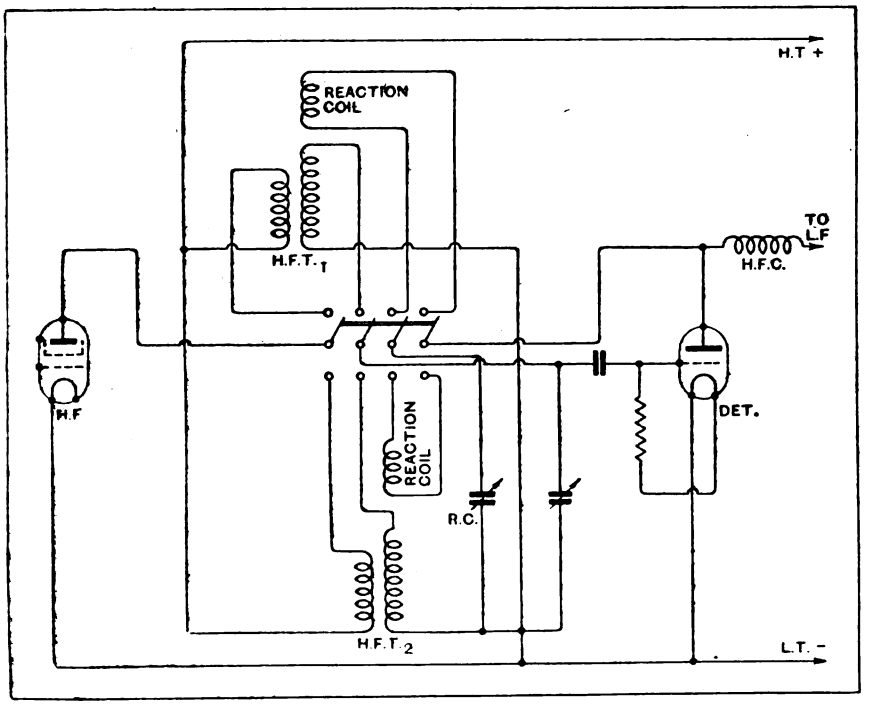

Fig. 2.—Connections for switching H.F. transformers and reaction coils where short-circuiting is not employed.

oooo

Gramophone Volume Control.

My set is fitted with a volume control resistance which is shunted across the L.F. transformer primary in the detector valve anode circuit. I am about to fit a pick-up, and should like to know whether the control will still be operative (and satisfactory) when the set is used for gramophone reproduction. J. D. S.

This all depends on the position of your pick-up, if it is inserted in the grid circuit of the valve in the anode circuit of which the shunted transformer is included, this method of volume control will work admirably. It would, however, be inoperative were the pick-up connected in the first grid circuit of a two-stage amplifier.

oooo

A Matter of Frequency.

(Referring to a reply to a previous query) . . . I notice that you recommend me to insert a 20,000-ohm decoupling resistance in series with the anode of my S.G. high-frequency valve. Can it be assumed that a lower value—say, 600 or 1,000 ohms, as usually specified—would do equally well? I have practically no surplus voltage in my accumulator H.T. battery; hence this question. P. M.

We do not recommend any considerable reduction in the value of the decoupling resistance, as suggested in our first reply. Your trouble is L.F. instability, which we concluded to be largely due to feed-back to the detector grid *via* the tuned anode coil; the H.F. side of the set is apparently quite stable. Therefore it is necessary to choose a decoupling resistance of a high value; although it happens to be in series with an H.F. valve, it is intended to cope (in conjunction with its associated by-pass condenser) entirely with L.F. currents.

oooo

Pentode Output.

I have a Marconiphone moving coil loud speaker which, as you will know, includes a built-in output transformer designed to work in conjunction with a valve of roughly 2,000 ohms impedance. My problem is this: I am building a new set, intended mainly for long-distance reception, in which a pentode output valve is to be used; will it be essential to replace the loud speaker output transformer with another instrument specially designed for the pentode, or will the existing output device prove to be satisfactory. T. E. W.

Strictly speaking, a special output transformer, with primary and secondary windings designed respectively for the impedances of the pentode and of the moving coil, should be used. However, you will find that the existing instrument, without any modification, will give very pleasing results, and we doubt if you will find it nesessary to alter it.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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THE BRITISH AMATEUR.

OUR recent comments on the status of the British amateur have provoked interest throughout the country, and by every post we are receiving letters from individual amateurs and from the various wireless societies. We are naturally only able to publish a few of these letters in our correspondence columns, but we would particularly refer our readers to certain letters which are to be found included in that section in this issue.

What stands out, perhaps, more clearly than anything else in the correspondence which we have received is the very positive evidence that the amateur is by no means dead, and that the same enthusiasm amongst amateurs still exists as it did in the past, but is lying dormant for want of leadership. This absence of proper leadership and failure to maintain the unity of the amateur movement is admitted in practically every communication which we have received, and admitted, too, with a tone of regret which leads us to believe that if an effort were made at the present time it would be possible to reunite and achieve the result which we so earnestly desire to see brought about.

There is a suggestion in some communications that *The Wireless World* should choose some existing amateur organisation and give it active support, and that by so doing the remaining organisations and individual amateurs could be brought together in a common organisation. This may sound all very well in theory, but we must say right away that we do not consider *The Wireless World* should be asked to shoulder the responsibility of making any such selection from amongst the existing amateur organisations.

It will be recollected that for a number of years *The Wireless World* acted as the official organ of the Radio Society of Great Britain, but that, at our request, we were released by the Society from that obligation for the reason that we wished to be entirely independent and not hampered in any way in our policy should we at any time consider comment or criticism necessary in the interests of the amateurs as a body.

Appoint a Committee.

We now desire to see some action taken to further what, evidence goes to show, is the common desire of the British amateurs to be once more united and able to speak with one voice. We do not ourselves feel that it is by any means essential that there should be but one so-called "parent society" if it should prove to be the wishes of the majority that the identity and individuality of the various organisations should not be lost. We think that by way of a start it should be possible for quite a small committee to be appointed whose duty it would be to investigate the whole amateur position and prepare a report for submission to those by whom the committee was selected. Representation on such a committee could conveniently be arrived at on the basis of net membership of the various organisations.

It is very essential that in any negotiations to this end the welfare of the amateur collectively should be borne in mind, and any temptation which may arise to take advantage of the opportunity to manœuvre for position, either as individuals or as societies, should be firmly suppressed.

We look to the amateur organisations to make the next move and, whilst for the reasons which we have given above, it is not our intention to interfere in the politics of the amateur or support any particular party, yet we shall welcome the opportunity of doing anything possible which would help to bring about a better understanding and a proper unity amongst British amateurs.

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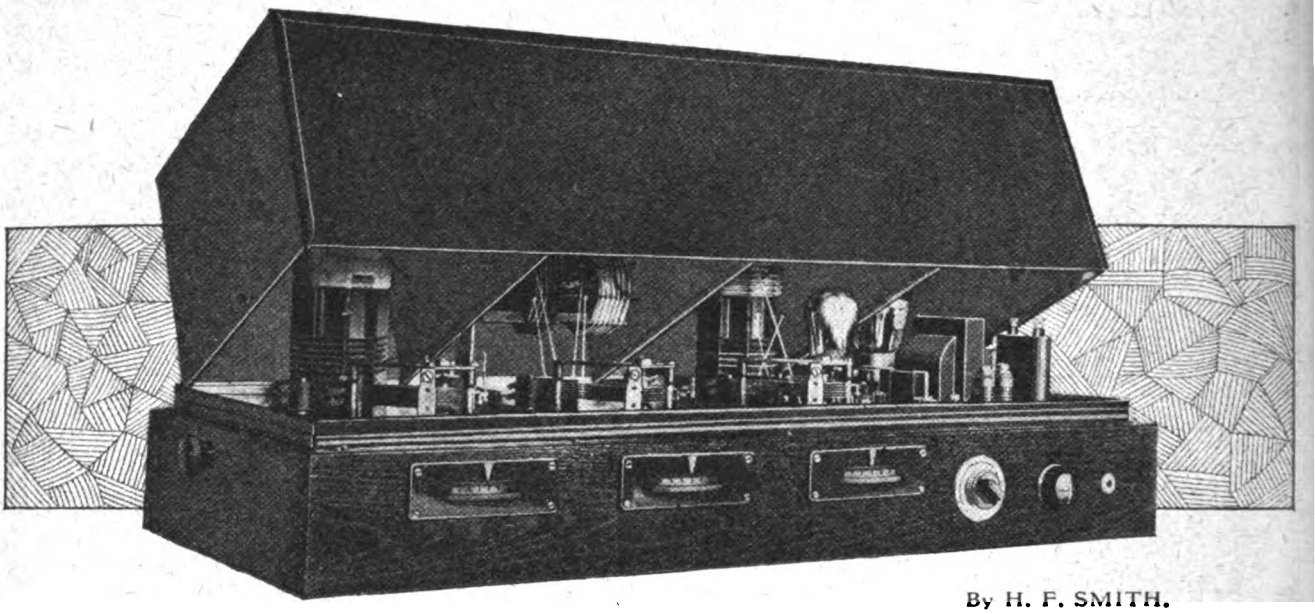

By H. F. SMITH.

Constructional Details and Operating Instructions.

(*Concluded from page 144 of last week's issue.*)

The New Kilo-Mag Four

HAVING prepared the formers for the two sets of intervalve couplings—the slots can best be turned in a lathe, but it is not too laborious a task to cut them with a saw and ward file—the process of winding may be started. Here, again, some form of mechanical winder is of advantage, but by no means essential. It is best to begin with the secondaries; for the medium-wave coil (left-hand section of Fig. 4 (C)) a total of 60 turns, disposed in 6 sections of 10 turns each of No. 26 D.C.C. wire will be required. It will be realised that the wire cannot be led straight from the end of one section to the beginning of the other as it would interfere with the interwound primary. This difficulty is overcome by placing a strip of thin insulating material measuring approximately 1in. by ½in. between two adjacent ribs in such a way that it rests against the tubular body of the former; when the end of a section is reached, instead of passing directly to the next, the wire is guided under this strip, and, in consequence, the space immediately between the "pancake" coils is kept clear.

Still winding in the same direction, and making similar provision for the primary, the long-wave secondary is wound in the remaining series of six deep slots, each of which is filled with 35 turns of No. 32 D.S.C. wire. The writer would take this opportunity of pointing out that this winding is identical with L_1, the long-wave aerial-grid coil, for which double silk-covered wire is also used—not D.C.C. as stated in the first instalment. It should also be stated that the foot of the H.F. transformer mounting bracket is turned inwards and not outwards as shown in Fig. 4. The low-potential end of the medium-wave winding and the high-potential end of the long-wave section are joined together and to the tag marked *y*.

It is difficult to be definite with regard to primary windings. As always, this is essentially a matter for compromise and adjustment if best results are to be attained: selectivity will be improved, and any tendency towards instability will be checked as the number of turns are progressively reduced below the optimum value giving most amplification.

Primary Turns: the Best Compromise.

Unfortunately, it is a fact that gains in these directions are obviously offset by a concomitant falling-off in sensitivity, but, thanks very largely to the use of anode-bend detection, is is possible to work with reasonably large primaries, and, for average conditions, it is safe to plump for a medium-wave coil of 32 turns of No. 40 D.C.C. wire (four sections of eight turns). The corresponding long-wave winding has 105 turns of No. 40 D.S.C. (three sections of 35 turns). The wire must be adequately insulated and spaced from the secondary, where it passes from section to section: this can be arranged by leading it diagonally over a strip of insu-

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The New Kilo-Mag Four.—

lating material of nearly the width of the space between adjacent ribs, or in any other convenient manner. Insulation between primary and secondary is a matter of some importance, and several cases of trouble with the original "Kilo-Mag Four" have been traced to defects in this respect.

In preparing the foregoing specification it is assumed that one of the popular types of S.G. valves, with an impedance in the order of a quarter-megohm, will be used. Fortunately, H.F. transformers are to a great extent self-adjusting to widely varying characteristics as they exist at the present time, and the transformers as described do not really call for any alteration when used with the new valves shortly to be available.

The method of mounting many of the components will be obvious from the accompanying photographs and drawings, but in two or three cases some few words of advice will be helpful. With regard to the wooden base—that illustrated is made of oak—it is recommended that the front panel should be not more than ¼in. thick; almost all components on the market are arranged for mounting on a panel of that thickness. Sides and back may be of ⅜in. wood.

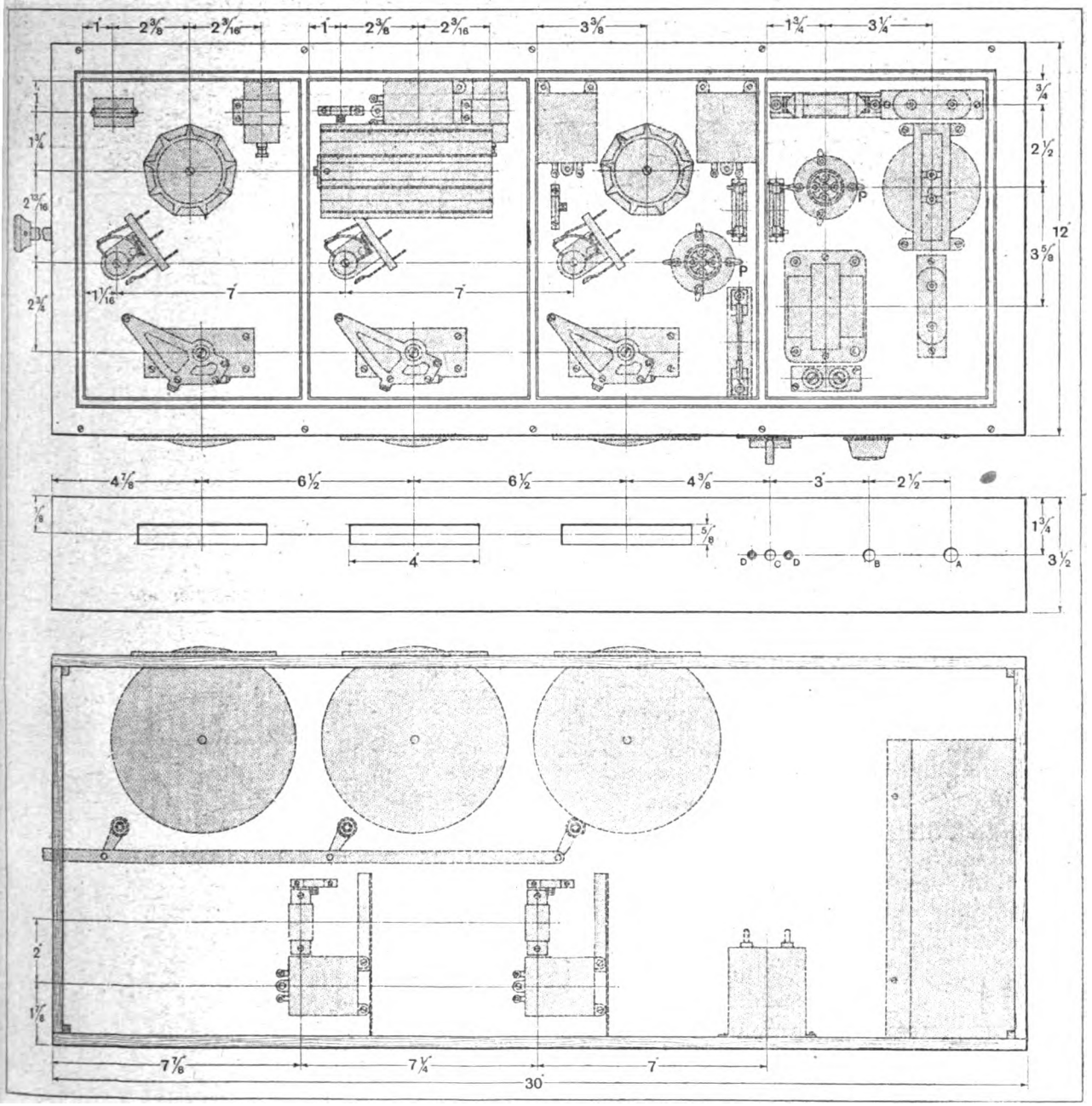

Fig. 5.—Layout of components in the screening compartments and in the base tray. In centre: drilling details of the front panel and positions of the condenser dial slots. A, 7/16 in. dia.; B, 3/8 in. dia.; C, 5/16 in. dia.; D, 5/32 in. dia., countersunk.

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The New Kilo-Mag Four.—

Detailed instructions for making the large edgewise tuning dials and their escutcheon plates need hardly be given, as it is understood that commercial products will shortly be available. Those used in the set described are experimental models, turned from ½in. ebonite sheet, with an overall diameter over the knurled rim, of 5¾in., and 5 9/16in. over the part carrying the scale (in the form of a band). Although weight could obviously be reduced by cutting away unnecessary material, it will be clear that these dimensions could not be substantially changed without altering the positions of the condenser spindle holes and possibly the dimensions of the container itself. As the diameter is so large, a slow-motion device is unnecessary.

It is desirable that the front panel of the base should be removable—it may be secured by wood screws to the side members—so that, after having fitted the condensers and dials, slots may be cut in the wood before it is placed in position, to coincide with the latter. Alternatively, these slots may be made oversize, so that the edges of the dials may be inserted in their slots and then raised to engage their centre holes with the condenser spindles. Of course, if this method of construction is adopted, the escutcheon plates must be large enough to conceal the apertures in the woodwork.

A very simple method of "ganging" the three switches has been adopted: though not above criticism on the grounds of mechanical soundness, it works quite satisfactorily, but can be altered to satisfy the hyper-

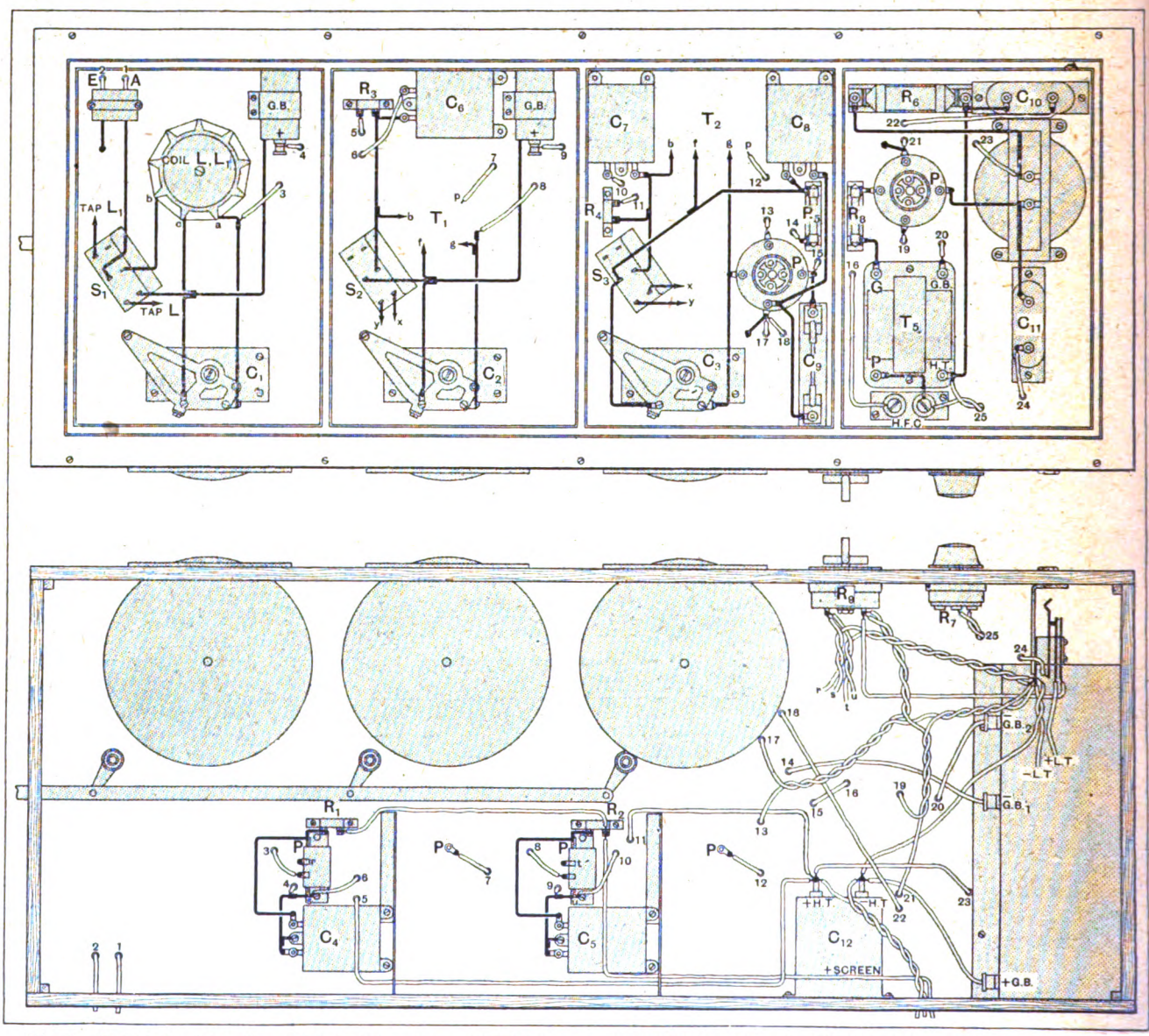

Fig. 6.—Practical wiring plan. H.F. transformers are not shown, but connections to their various terminals are indicated by the letters p, g, f, etc. Similarly, H.F. valve filament leads, run in the manner shown in the preceding photograph, are broken, their connections to the valve holders being indicated by corresponding lettering. Wires passing through the base are numbered in the same manner. Note that the holes for plate and grid leads passing out from the screened compartments are in such a position that the unshielded length is as short as possible.

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The New Kilo-Mag Four.—

critical by the addition of an extra link and two guides. The control as shown is effected through a strip of brass, $\frac{1}{8}$in. × $\frac{1}{16}$in., measuring 18in. in length. Three holes, 7in. between centres, are drilled through this strip and correspond with holes drilled in the arrowhead switch pointer arms. A 6 B.A. screw, secured by a nut and locknut, is passed through both holes at each point, sufficient looseness being allowed to ensure free movement. One end of this strip passes out through a slot in the side of the inverted base tray and is fitted with a knob, the slot must be slightly wider than the width of the strip, of which the movement is not entirely confined to a lateral direction.

There is no need to insulate the "one-hole fitting" bushes of the switches from the metal work; they can easily be mounted through holes of the correct diameter, but some care should be taken to set them at the correct angle, so that the pointers are facing towards the front of the set when the moving contacts are at "off."

Many components can be secured by short wood-screws passing through the metal base into the plywood sub-baseboard, or, in the case of those on the lower compartment, directly into the wood, but in several instances it is best to use 6 B.A. or 4 B.A. screws and nuts, particularly in mounting the large by-pass condensers, of which the metal cases should be earthed.

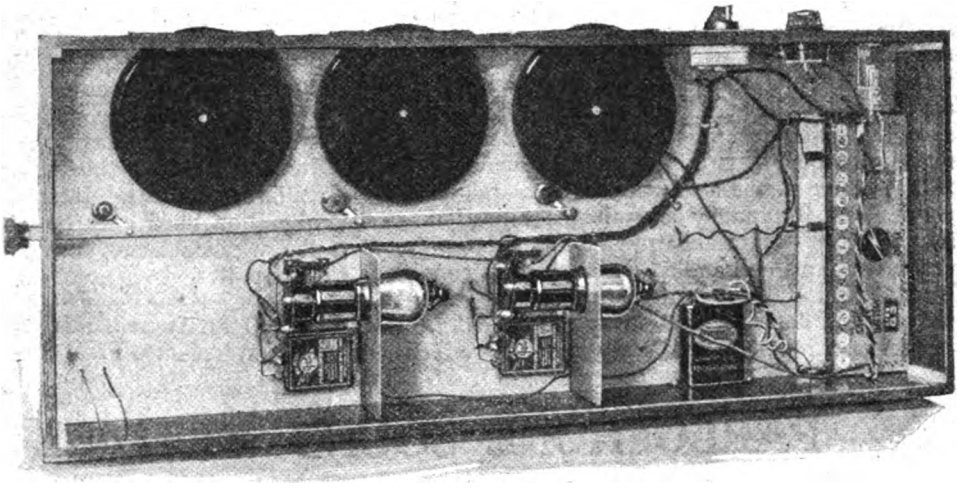
Points Needing Special Attention.

It will be seen that the single bias cells are held in position by simple metal clips, and that all three tuning condensers are mounted on rectangular strips of ebonite, it is necessary that their spindles should be insulated by drilling large clearance holes through the metal.

For wiring up the set, it is convenient to use both stiff wires and flexible leads. The former are suitable for use inside the screening compartment, while the latter will serve for connections in the base and for those passing through it. In cases where these are at high potential they may well be insulated from the metal by a short length of sleeving in addition to their rubber covering.

Each negative filament terminal should be "earthed" direct to the nearest point on the metal base; in the case of the H.F. valve, this is conveniently done by taking a lead to the head of one of the by-pass condenser holding-down screws, which passes through the wooden sub-baseboard and makes contact with the metal work.

It will be observed that the volume control resistance R_7 (see Fig. 6) is fitted with three terminals, one of which is idle. The component actually used is a potentiometer, but, for our present purpose a simple variable resistance only is necessary. Another small point likely to puzzle the constructor is in connection with the detector anode circuit wiring. Referring to the same diagram, a lead is passed down from the third screening compartment (from the left) into the base, and then up



Interior of the base compartment.

again into the "L.F." section and to the high-frequency choke. Of course, this wire could equally well be led through an aperture cut in the channel between the two compartments, but it was judged to be quite unnecessary to complicate the construction of the container by this addition. The connection in question is numbered 15 and 16.

With regard to the choice of H.F. valves, nothing need be added to what has already been said; for a detector, the Marconi or Osram "D.E.L." class or a Mullard "D." or "D.X." in 2-, 4- or 6-volt ranges are representative of the best type of valve for the rather difficult function of anode bend detection preceding an L.F. transformer. It is possible to load quite an ambitious valve—say a P.625—in the L.F. position without running into detector grid current, and, where an H.T. voltage in excess of 150 is available, it is best to provide a separate feed for the output valve. On voltages of between 120 and 150 a common anode supply with an extra connection for the screening grids, as provided in the design, is both adequate and simple.

Small metal screens of sheet aluminium measuring 3in. deep by 5in. wide are fitted to the H.F. valve, but, in view of the particular constructional methods adopted they can hardly be considered as essential, although it is just possible to detect a slight improvement in stability when they are mounted in position. As usual, these shields should coincide with the internal screens of the valves; they are "earthed" through their securing screws, which make contact with the metal base.

If there is any tendency towards self-oscillation as the circuits are brought into tune, the first step should be to assure oneself that screening is as perfect as possible, and all contacting surfaces on cover and base

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The New Kilo-Mag Four.—

should be carefully examined. If the trouble still persists, a few turns may be removed from the "plate" ends of the transformer primaries. It shoud be emphasised that this course will seldom be necessary, and that the need for any considerable reduction will indicate faulty screening or decoupling, or will suggest that the residual capacity of the H.F. valves is above the average.

A similar procedure may be adopted in order to increase selectivity in exceptionally difficult situations, but before altering the primaries it is well to try the effect of moving the aerial tapping nearer to the earthed end of the aerial-grid coil, medium- or long-wave, as the case may be. It is useless to blind ourselves to the fact that either of these adjustments will reduce signal strength, but fortunately overall magnification, even with a primary appreciably smaller than the optimum, is as great as can be handled under average conditions.

In any case, if this loss of sensitivity is considered as objectionable, there is a way out of the difficulty. Dare it be suggested that a separately tuned aerial circuit, involving one more control in a set already having three condenser dials, should be considered as a possible elaboration? The writer will take the risk of doing so, and, with the Editor's permission, hopes to describe a way of introducing this refinement as an addition rather than as an alteration to the design as it stands. A two-circuit tuner, by reducing shock-excitation of the input grid circuit, improves selectivity to an extent that can hardly be attained in any other way—even by reducing coil resistance to a value low enough to bring about a definite and perceptible loss of high notes. An extra tuning control is not a serious drawback in a set having more than one, or perhaps two, variable condensers, which must of necessity be operated either on the "step by step" plan or by reference to a previousy prepared calibration chart. It should be made clear that this alteration need only be considered by those living, in the wireless sense, under the shadow of a powerful transmitter.

This set is available for inspection at the Editorial Offices, 116-117, Fleet Street, London, E.C.4.

PARLOPHONE SOUND TEST RECORDS.

A Convenient Source of A.C. for Acoustic Experiments.

THESE records have been produced by the Parlophone Co., Ltd., 85, City Road, London, E.C.1, under the supervision of Drs. E. Meyer and H. Salinger, of the Heinrich Hertz Institute, Dusseldorf. The work of Dr. Erwin Meyer in connection with loud speaker characteristics is already known to readers of this journal and the Parlophone records embody the fruits of his experience in this sphere.

The first record in the series (No. P9794—I) gives a pure sine wave output starting at 6,000 cycles and falling steadily to 100 cycles. A curve is supplied with the record giving the frequency at any point in terms of the number of revolutions from the commencement of the 6,000 cycle note or alternatively in terms of the distance of the needle in centimetres from the starting groove. Provided the speed of the turntable is carefully adjusted to 80 revolutions per minute this method of estimating the frequency at any point will be sufficiently acurate for all practical purposes and should prove invaluable to experimenters who lack the musical training required to estimate frequency by ear.

The applications of this record are numerous. In the first place it may be used to examine the output characteristics of gramophone pick-ups, a valve voltmeter being connected across the leads to measure the terminal voltage. Resonances will thus be indicated visually, and the frequencies at which they occur can be easily ascertained by keeping count of the number of revolutions of the record.

An examination of the groove reveals that the amplitude of the sine wave increases as the needle approaches the lower frequencies near the centre of the record. In order to obtain a constant A.C. output the amplitude should vary inversely as the frequency, but a deviation from strict proportionality amounting to two decibels (about 25 per cent.) is permissible before the difference can be detected by the human ear. The makers state that the amplitude is correct to ± 20 per cent., so that for most acoustic purposes the output may be regarded as constant.

Having used the record P6964-I to discover a pick-up having good characteristic, the output may be amplified through one or more stages of resistance coupling and applied to any type of loud speaker, when it will be possible to obtain an aural estimate of the quality of reproduction. The frequencies at which resonances occur can be arrived at in terms of the position of the needle on the record, and it will be possible to judge whether the acoustic output is evenly distributed over the frequency scale or limited to certain definite zones. A little practice with a good moving coil speaker as a basis for comparison will soon give the experimenter a standard by which to judge performance. He will also be able to recognise the change in quality which indicates that the loud speaker movement is itself introducing harmonics.

A word of caution is, however, necessary in connection with the use of the P6474-1 record for loud speaker tests. It is well known that standing waves are formed in a room due to reflection from the walls. This fact can be easily verified by closing one ear and moving the head towards one of the walls during the transmission of the B.B.C. tuning note. In the case of the continuously changing frequency there is a continual redistribution of the nodes and antinodes. Whenever one of these antinodes passes the head of the observer it causes the illusion of a resonance in the loud speaker itself. The same applies when a condenser microphone is used to make accurate measurements of the acoustic output, and it is for this reason that this work is generally carried out in the open.

This source of error has been ingeniously overcome on the reverse side of the continuously decreasing frequency record. The same range of frequencies is covered by this record (No. P9794-II), but a rapid fluctuation of ± 50 cycles is superimposed which causes the nodes and antinodes to move their position slightly. Actually the standing waves shift their position 10 times per second, which effectively eliminates the semblance of imaginary resonances and gives a true *mean* reading at any point in the room.

Standing waves are also troublesome when determining the echo characteristics of rooms and the permeability of walls to sounds of various frequencies and special records for work of this nature have been included in the Parlophone Sound Test series. In these records the mean frequency is constant, and as distinct from the falling mean frequency of the P9794-II record. The mean frequencies and $\frac{1}{10}$ second variations of frequency are as follows :—

Record.		Mean Frequency.	Variation.
P 9795	I	150	± 50
	II	300	± 50
		600	± 50
		1200	± 50
P 9793	I	4800	± 50
		2400	± 50
	II	950	± 650
		1800	±1600

The complete set of three records in an album, together with instruction booklet, costs two guineas, and supplies are obtainable direct from the address given above.

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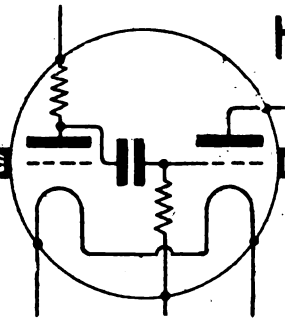
NEW H.F. AMPLIFIER CIRCUIT



Remarkable Stage Gain Using Aperiodic Coupling.

MOST readers will know, by name at least, the multiple valve made by the Loewe Radio Company containing in one large bulb a detector valve, a low-frequency amplifier, and an output valve, together with the necessary resistances and coupling condensers. This valve was used in *The Wireless World* "Multiple-valve S.G. Portable" set (April 17th).

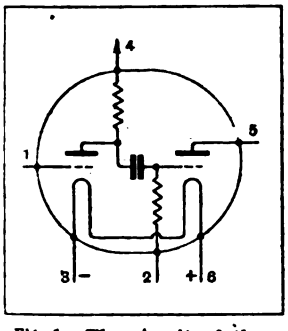


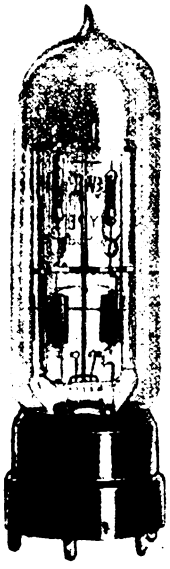
Fig. 1.—The circuit of the amplifier within the bulb of the double valve.

The method of construction makes for cheapness and compactness, but in a low-frequency amplifier the reduction of unwanted capacity afforded by such a mode of construction can at best offer only a small reduction of the loss of high notes for a given degree of amplification per stage. Up to the present all efforts to attain good amplification at high frequency by resistance coupling have failed, to some extent at least, on account of these same stray capacities, so that it would seem that the assembly of the entire amplifier, with coupling resistances and condensers, in a single bulb would offer considerable possibilities in this direction. Such an assembly has been available for some time in the Loewe 2H.F. multiple valve, which contains two four-electrode valves and is suitable for use where one such valve only is required to precede the detector.

Stray Capacities Reduced to a Minimum.

This model, however, has not been found completely satisfactory where several such valves are to be used in series, and for this particular purpose a new model has been designed. Specimens of this type have reached us from Germany for test, but manufacture in England has not yet commenced. Nevertheless, it is felt that readers will welcome advance information of this valve, which is of unusual interest in several respects.

The bulb contains two complete three-electrode valves, one anode resistance, one coupling condenser, and one grid-leak, and is equipped with a six-pin base for use with the special valve-holder used for the other types of multiple valve. In Fig. 1 the large circle represents the bulb, which contains all components shown within the circle. The points numbered 1 to 6 represent the six pins of the base, the numbers running consecutively round the base of the actual valve.



A general idea of the structure of the multiple valve may be gained from this photograph. The anode resistance and the grid-leak may be seen above the valves proper.

One of the first points in construction that attracts attention is the design of the base. Six equidistant pins are mounted on a ring of insulating material, and the wires coming through the glass "pinch" from the electrodes are led direct to the pins and soldered. To prevent damage, a thin disc of insulating material, which does not touch any metal connections at any point, fills up the centre of the ring. Any losses due to this disc should be negligible.

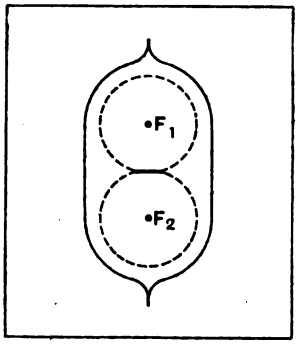


Fig. 2.—Diagrammatic representation of one valve. The filaments F_1 and F_2 are connected in parallel, the grids have a common support, and one plate surrounds the whole. The doubling of filament and grid serves to improve the characteristics of the valve.

Apart from the fact that one pair of leads (4 and 5) cross on the way from the pinch to the pins, it would seem that both dielectric losses and stray capacities due to the valve-base have been reduced to the commercially practicable minimum.

The assembly is built up on a "U" of glass, of which the bottom forms the pinch through which the leads are taken. The valves themselves sit side by side at the bottom of the "U," and are noteworthy for the fact that each contains two straight two-volt filaments connected in parallel. Each filament has its own grid, the two being mounted on a common support, and the whole is surrounded by a single plate, as indicated in Fig. 2. The filaments of the two valves are connected in series, so that the unit requires a 4-volt accumulator, from which it draws a filament current of 0.37 amp.

Immediately above the valves proper, set vertically and at right-angles to the plane of

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New H.F. Amplifier Circuit.—

the "U," is the coupling condenser, which is joined to the plate and grid respectively of the two valves by leads less than half an inch long, and spaced as far away as possible from all other leads and components. This condenser, we understand, has a capacity of the order of 0.0001 mfd.

On either side of the condenser a resistance of "grid-leak type" is mounted vertically; one actually is a grid-leak, the other the anode resistance. Rather long leads run the whole length of the bulb from the top end of these resistances to the pinch (2 and 4), but as both are at earth potential so far as signals are concerned this is of no great consequence. Leads 1 and 5 come through the pinch at opposite ends, and extend above it for less than half an inch. It is apparent that great care has been taken in the whole layout and construction of the valve to avoid any unnecessary additions to the stray capacities which, if allowed to rise above a very small value, would be liable to reduce the amplification to negligible proportions.

The Static Characteristics.

The static characteristics of the valve were measured as nearly as practicable in the manner employed for those of ordinary valves. It will be seen from Fig. 1 that if the terminal 2 is connected to the L.T. – terminal 3 the second valve is given a grid-bias of –2 volts, owing to the voltage drop of this amount in the filament of the first valve. With this connection made, which represents practical working conditions, the anode current of the second valve alone was measured for different anode voltages. The figures obtained are shown in the curve of Fig. 3, and lead to the value of about 13,000 ohms for the A.C. resistance of the valve.

Measurements of the plate-current at different grid voltages elicited the fact that grid current does not flow provided that the grid is not less than 1.2 volts negative with respect to its own filament, and that the amplification factor of the valve examined was 10.

The assumption was then made that the two valves in the bulb were identical in electrical performance as well as in appearance, and on this basis it was found,

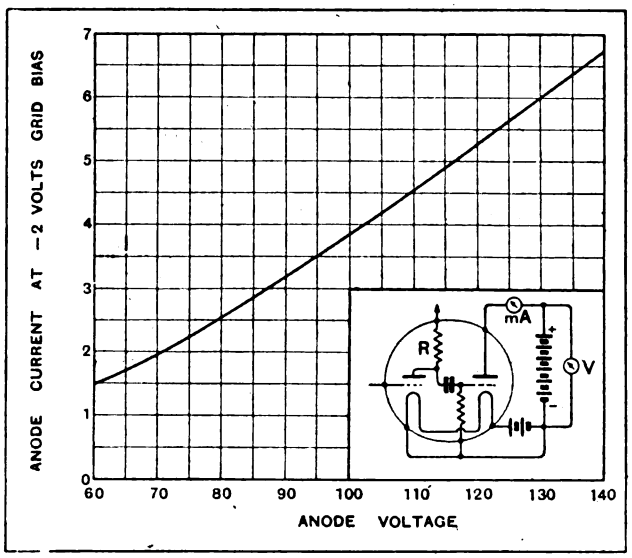

Fig. 3.—Plate-voltage plate-current characteristic of second valve in the Loewe 2H.F. multiple valve, without anode resistance and "natural" grid bias of –2 volts. The circuit is as shown. The valve characteristics are as follows: R_a=13,000 ohms at 150 volts, or 18,000 ohms with plate resistance of 22,000 ohms. μ = 10.

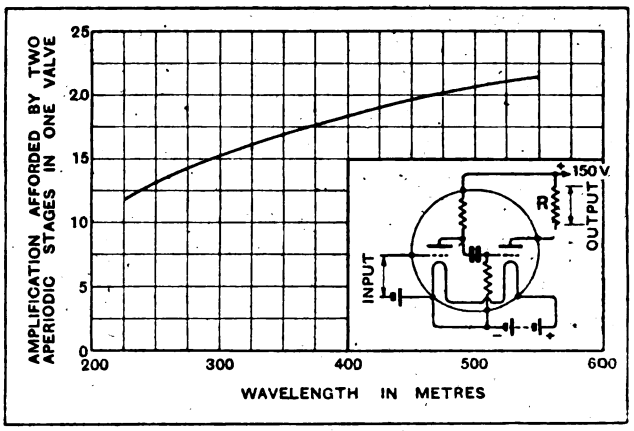

Fig. 4.—Measured amplification of multiple valve at various wavelengths. The resistance R is 22,000 ohms.

by taking the characteristics of the first valve, that the anode resistance incorporated in its plate circuit had a value of 22,000 ohms, and that with the resistance in position this valve had an A.C. resistance, under normal operating conditions, of 18,000 ohms.

With these figures available it is possible to calculate the amplification that should be attained by each of the stages in the double valve, using an external anode resistance of 22,000 ohms for the second valve, and ignoring the effects of inter-electrode and stray capacities in lowering the amplification. On this basis the amplification of each stage should be 5.5 times, giving $(5.5)^2$ or about 30 times as the overall amplification of the two stages. For comparison with this the amplification actually attained at various wavelengths within the broadcast range was measured, the results obtained being plotted against wavelength in Fig. 4. It will at once be seen that the amplification achieved varies between 10 and 21 times over the range investigated—results which are extremely good for resistance amplification at the wavelengths mentioned.

At first sight, it may be surprising that valves of so low an amplification factor as 10 should be employed for a resistance-coupled amplifier, and one may be inclined to suggest that if valves of the high-impedance type had been used instead the amplification would have been greater. It is a well-known fact, however, that the inter-electrode capacities of a valve under working conditions rise very rapidly as the amplification factor of the valve is increased, being, indeed, very approximately proportional to this figure. Consequently as the "μ" of the valve is increased the proportion of the theoretical amplification that is attained in a practical high-frequency amplifier drops very rapidly, and such valves give, for this purpose, not

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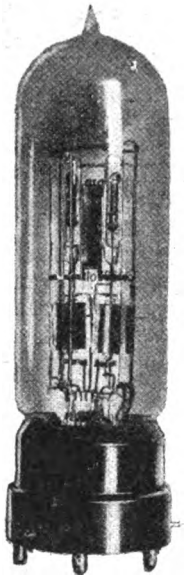
more but less actual amplification than those of lower amplification factor. The drop in amplification due to stray capacities becomes most rapid when the actual amplification is in the neighbourhood of 70 per cent. of the theoretical value, so that if valves of higher amplification factor than correspond to this condition are used the theoretical increase is more than offset by the extra loss due to additional stray capacity. If, on the other hand, valves of lower "μ" are employed, the closer approach of actual to theoretical amplification is more than counterbalanced by the decrease in the amplification factor of the valves. There is thus an optimum value for the amplification factor of the valves, above and below which the amplification attained in practice falls off, and the value chosen must be such that the amplification is some 70 per cent. of that calculated without allowing for stray capacities.

It is interesting to note that at 300 metres the amplification given is 15 times for two stages, or 3.9 times for one stage, and that this value is exactly 70 per cent. of the theoretical amplification of 5.5 times that one stage would yield if stray capacities could be neglected. This comparison confirms the belief that this multiple valve is very skilfully designed, and suggests that it offers the greatest measure of aperiodic amplification that is likely to be achieved on the broadcast band for some time to come.[1]

Owing to the fact that no resistance is incorporated in the anode circuit of the second valve of the assembly, a tuned circuit can be used, if desired, to couple the multiple valve to the valve that follows it. When the next valve is another high-frequency amplifier, the use of a tuned circuit as coupling is optional, but the designer of the valve strongly recommends that a tuned circuit should immediately precede the detector valve, since by this means freedom from motor-boating and kindred troubles is assured. The reader will therefore be tempted to enquire as to the overall amplification that may be expected from this arrangement, which is shown diagrammatically in Fig. 5.



Taken from a slightly different angle from the last, this shows the position of the coupling condenser, placed between anode resistance and grid-leak.

[1] Since examining this valve, a newer model, none of which has yet appeared in England, has been designed. It follows the valve here described very closely, but the two stages taken together give nearly 30% greater amplification.

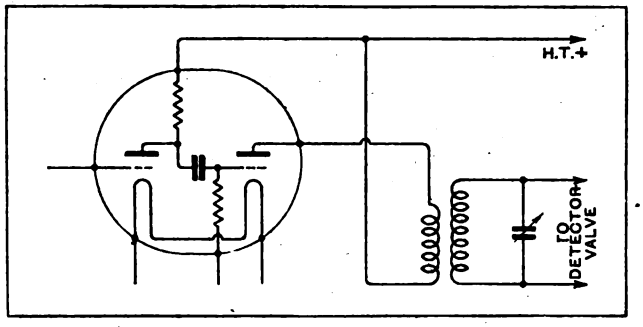


Fig. 5.—The multiple valve followed by a high-frequency transformer in place of a resistance. No neutralising is required. The overall amplification afforded by this circuit is about 100 times at 300 metres.

The second valve, with a standard Litz coil of 68 turns on a 3in. paxolin former as transformer secondary, requires a primary of some 14 or 15 turns, and may be expected to give an amplification of about 23 times at 300 metres. This, together with the measured amplification of 3.9 times due to the first resistance-coupled stage at this wavelength, gives a reasonable expectation of a total amplification of 90 times. On measurement the amplification at this wavelength turned out to be 102 times, the excess being very readily accounted for by the fact that the change in effective capacity caused by altering the output circuit from resistance to transformer coupling slightly increases the amplification of the first stage.

Absence of Input Damping.

All the measurements of amplification so far mentioned were made by feeding to the first grid of the multiple valve a voltage obtained by passing a measured high-frequency current through a resistance of known low value. There was thus no opportunity for the valve to decrease the voltage applied to its grid

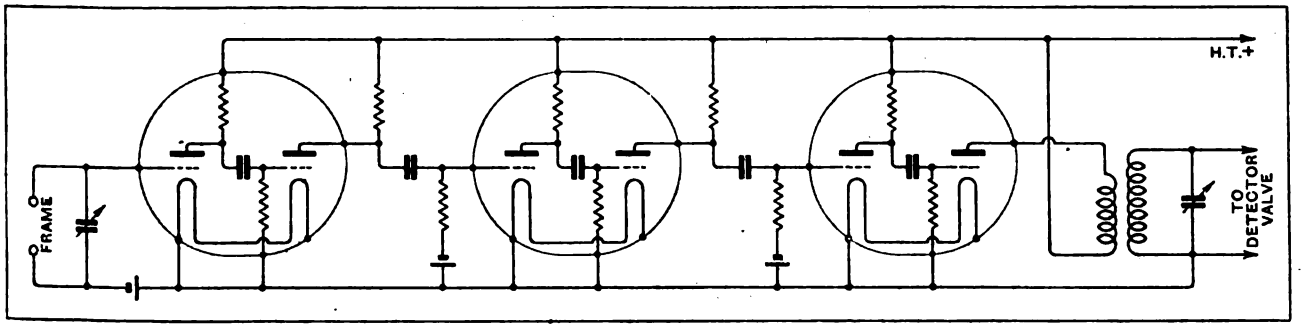


Fig. 6.—A high-frequency amplifier built up from three multiple valves. The overall amplification would be about 20,000 times at 300 metres, but the selectivity would be that associated with two tuned circuits only. Compare Fig. 7.

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New H.F. Amplifier Circuit.—

by the negative reaction that is usually a prominent feature of aperiodic amplifiers. If, however, the valve is to be connected across a tuned circuit, such as a frame aerial, having, say, a dynamic resistance of a quarter of a megohm, this effect, if present, may be very serious. If reception is carried out on a frame, and this is damped by the valve to such an extent that only one-tenth of the normal voltage is developed across it, then this reduced voltage, after a 15-times amplification, would be only 1½ times that obtained from the frame direct, and for all practical purposes the valve would be useless.

A frame aerial was therefore connected to the grid of the valve, and the voltage developed across it by the local station was measured with the filaments of the multiple valve first cold and then heated. Resistance-coupling was in use in both stages, and the normal working voltages were applied. It was found that the voltage on the frame rose by about six per cent. when the multiple valve was lighted, showing that so far from there being any damping introduced into the frame-aerial circuit, there was a small gain due to reaction. The full measured amplification of the valve will therefore be effective in a practical receiver, with a trifling bonus thrown in.

This valve has been discussed at some length, although it is not yet available to the general public (we understand that it will be in full production this autumn) partly because it raises a number of problems of considerable practical and theoretical interest, and partly because it offers an opportunity, for those who are so inclined, to design or build receivers of novel type.

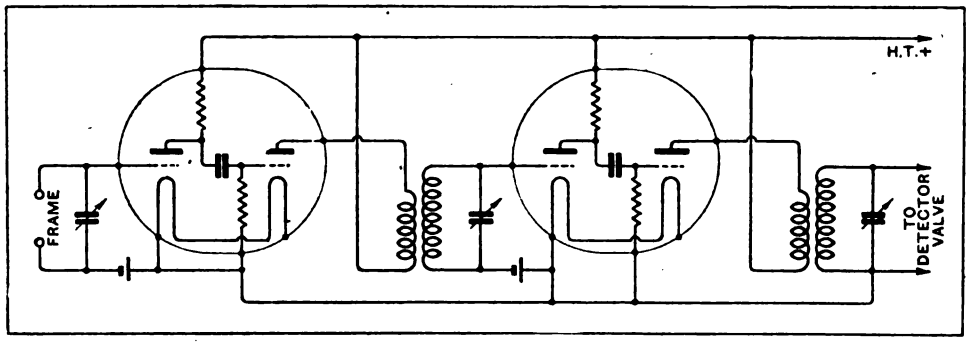

Fig. 7.—A high-frequency amplifier containing two multiple valves. The overall amplification would be about 10,000 times at 300 metres and the selectivity would be high, as there are three tuned circuits. Compare Fig. 6.

Ordinarily, it is necessary to add one tuned circuit to the receiver for every valve acting as high-frequency amplifier, with the result that both the design and operation of a highly sensitive set become very difficult. Even if the most extensive screening is employed, the stability of a receiver containing two or three stages of efficient high-frequency amplification is usually a matter for speculation until the set is built, and if, as is likely, such a set is to be used with a frame aerial the selectivity attained is usually excessive, so that tuning becomes unnecessarily difficult, and the side-bands of received telephony are liable to be cut off. With an aperiodic amplifier these difficulties are less prominent, though high amplification can readily be attained by using a sufficient number of stages. Moreover, the selectivity can be adjusted independently of the sensitivity, for one may use just enough tuned circuits to give the selectivity that is found necessary, and then make up the total amplification with aperiodic stages.

Receivers for the Valve.

With the valve we have discussed, for example, an overall amplification of the order of 10,000 times might be attained in either of two ways. Three double valves might be connected in cascade, using, besides the frame, only one tuned circuit immediately before the detector, as suggested in Fig. 6. Or, if the selectivity conferred by two tuned circuits were regarded as insufficient for the particular locality in which the receiver was to be used, one might prefer to employ only two double valves, using a tuned circuit as coupling between the two as well as immediately before the detector, as in Fig. 7. The amplification attained would be very roughly the same in both cases, but there would be a very considerable difference in selectivity between the two receivers.

In an amplifier in which tuned couplings are used throughout it is inevitable that the amplification attained should be greater at the lower end of the tuning range than at the upper. It will be seen from Fig. 4 that with the resistance-coupled stages of the multiple valve the opposite effect is experienced, the amplification rising as the wavelength is increased. It will therefore be clear that by a judicious combination of tuned and aperiodic couplings it should be possible to construct a receiver yielding practically constant amplification over the whole of its tuning range or with any desired wavelength-amplification characteristic.

BOOKS RECEIVED.

Code for Protection against Lightning.—Approved April, 1929, by the American Standards Association. With Appendix giving short dissertation on lighting, its origin, characteristics and effects. Published by the Bureau of Standards, Washington, D.C., U.S.A. Price 25 cents.

Der Weg zum Rundfunkhören, by Dr. Hanns von Hartel.—Describing the nature and functions of apparatus in general use for broadcast reception. Pp. 56, with 38 illustrations. Published by Rothgiesser und Diesing A.G., Berlin. Price R.M. 1.30.

Kennrufe der Rundfunksender.—List of 170 European broadcasting stations giving the geographical position, wavelength, identification signals and other particulars of each station. Pp. 173. Published by Rothgiesser und Diesing A.G., Berlin. Price R.M.2

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Events of the Week in Brief Review.

CHICAGO'S FLYING SQUAD.

The Chicago police department is so impressed with the efficiency of Scotland Yard's flying squad that it intends not only following their example, but even going one (or many points) better. We hear that a 5 kW central station is to be erected, and 150 cars are equipped with wireless receiving sets. The larger cars are to be manned by five police officers, and will be armed with machine guns, shot guns, tear bombs, cameras and finger-print equipment. The enterprising burglar will have no cause to lament the monotony of life and the lack of thrills in the pursuit of his calling.

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WIRELESS PHOTOGRAPHY IN AUSTRALIA.

Pictures of events in Australia will probably be transmitted to us at no very distant date, as Amalgamated Wireless (Australasia), Ltd., who own the majority of the important broadcasting stations in Australia, have concluded with Messrs. William Blogg and Co., Ltd., the Fultograph agents in that country, a five years contract for a still-picture service. Transmissions from Melbourne are expected to begin shortly. All short-wave enthusiasts in this country will hope that 3LO, the 31.5-metre Melbourne station, which is now temporarily closed, will start work again, and that we shall have still pictures from the Antipodes. Both 3LO and 2FC (Sydney) on 31.28 metres are well heard over here, and there is no reason why good reception of pictures from the other side of the world should not be possible.

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CANADA'S SHORT-WAVE STATION.

CJRX, the short-wave broadcasting station, has been moved from the Grain Exchange Building in Winnipeg to a point about 10 miles from the city, and is now transmitting again on 25.5 metres with an input of 2 kW. Reports on the new station's signals will be welcomed by the owners, Messrs. James Richardson & Co., Grain Exchange Buildings, Winnipeg, Manitoba.

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A VERY NORTHERLY STATION.

The Russian expedition to Franz Josef Land has selected a site for the wireless station on Hooker Island, and has already begun to unload material for its erection from the ice-breaker. The proposed station will be 80° 19′ N.

A GOOD MIXER.

We understand that it is intended to install an "inverter" at the experimental short-wave station of the International Telegraph and Telephone Corporation at Trappes, near St. Cyr, France. The object of this apparatus, which we believe has been designed by Standard Telephones and Cables, Ltd., is to prevent telephone messages being picked up by promiscuous listeners, and this result is achieved by inverting the frequencies of the speech sounds so that high notes become correspondingly low and low ones high until the receiving equipment reconverts the frequencies to normal. Wireless eavesdroppers, therefore, who may chance to pick it up will probably think they are listening to ultra-modern music.

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BERLIN WIRELESS EXHIBITION.

The annual Wireless Exhibition, which, as stated in our issue of July 10th, will be opened at Berlin on August 30th and continued until September 8th, will no doubt attract a great number of wireless enthusiasts from all parts of the world to the Kaiserdamm grounds. It will surpass its predecessors in size and interest.

FIRST LAMME MEDALLIST.

The late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Co., under the terms of his will directed that a medal should be given "for meritorious achievement in the design of electrical machinery," the recipient to be chosen by the American Institute of Electrical Engineers. The first holder of the Lamme medal is an Englishman, Mr. Allen Bertram Field, Consulting Engineer to the Metropolitan Vickers Co., Ltd., for "the mathematical and experimental investigation of eddy-current losses in large slot-wound conductors in electrical machinery."

The ceremony of presentation was broadcast through the short-wave set of KDKA.

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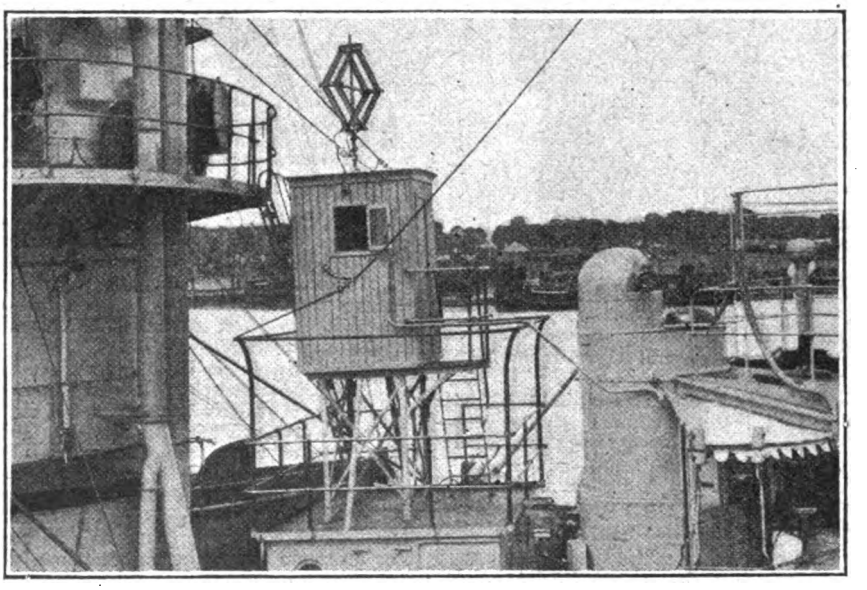
MAGNUM UNIVERSAL, A CORRECTION.

We regret two errors in our description of the "Magnum Universal" broadcast receiver which appeared in our issue of August 14th. On page 151 the captions to the two illustrations were inadvertently reversed and the price should have read £18 and not £10. We trust that the manufacturers, Messrs. Burne-Jones & Co., Ltd., 296, Borough High Street, S.E.1, have not been inconvenienced by the error.



Photograph taken on board the Italian cruiser Ferruccio, showing the special directional frame aerial equipment housed separately from the main wireless installation.

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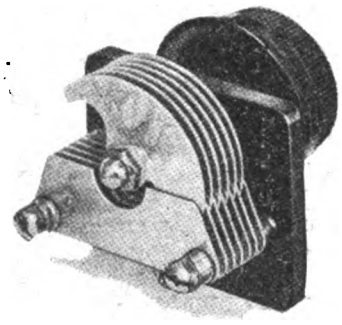
A Review of Manufacturers' Recent Products.

"MAGNUM" REACTION CONDENSER.

This is a miniature variable condenser particularly suitable for use in portable and transportable sets or in such cases where panel space is strictly limited. Furthermore, the minimum capacity has been kept as low as possible so as to permit of its use also in sets fitted with H.F. stages.

The moving vanes have been shaped to give a gradual increase in capacity on first interleaving with the fixed plates. This feature contributes to easy control of reaction, especially in such cases where a small feed back is sufficient to start oscillation.

The measured minimum capacity of the sample sent in for test was 5.5 micro-microfarads, and the maximum capacity 0.000094 mfd. It is rated as a 0.0001 mfd. condenser. A single hole fixing bush is fitted together with one end



"Magnum" miniature reaction condenser.

bearing for the moving vanes. This is of generous size and there is no trace of "whip."

The makers are Messrs. Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1, and the price is 4s.

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PHILIPS' LOUD SPEAKER, MODEL 2007.

This consists of a free-edged cone diaphragm driven by a differential movement, the whole being carried on a moulded frame. A feature of special interest is the provision of a dished baffle supported on four pillars and mounted in front of the cone. An annular space is left between the baffle and the frame for the egress of the

Philips' cone loud speaker. A switch to adjust the impedance for best operating conditions is incorporated in the lead.

sound waves. The cone is, therefore, working against a cushion of air; the conditions obtaining in a horn-type loud speaker being partially reproduced without the attendant disadvantages. This undoubtedly contributes to the good sensitivity to weak electrical inputs recorded during test.

An addition of no little importance is a three-position switch which enables the impedance of the instrument to be adjusted to the value most suitable for the particular valve used. Measurements of the D.C. resistance of the windings show that this gives a choice of either 490 ohms, 1,340 ohms, or 1,840 ohms. The highest value was found to give the best all-round results in conjunction with output valves between 4,000 and 6,000 ohms A.C. resistance.

Speech is clear and crisp and on music the general level of response is good over the whole audible scale. There are no objectionable resonances. Models are available finished in orange, black and gold; violet, black and gold; or brown, black and gold; the price being £5 5s. The makers are Philips Lamps, Ltd., Philips House, 145, Charing Cross Rd., London, W.C.2.

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MOVING COIL LOUD SPEAKER "POT" WINDINGS.

Since one of the principal factors governing the efficiency of a moving-coil loud speaker is the ampere turns on the field coil, this portion of the equipment requires very careful and skilful winding. Pots energised from the mains are less difficult to wind than those drawing current from a low-voltage accumulator, since in the first case a fine gauge of wire is used, whereas in the low-voltage types a very heavy gauge must be employed.

Cromwell pot coil wound with special "ribbon" wire.

Hitherto the amateur experimenter has been obliged either to wind his own pots, probably without adequate facilities, or adapt the commercially made article to his particular design. The Cromwell Engineering Co., 81, Oxford Avenue, Merton Park, London, S.W.20, have now developed a new type of ribbon-wound coil, and it is claimed that many more turns can be accommodated in a given volume than with round section wire.

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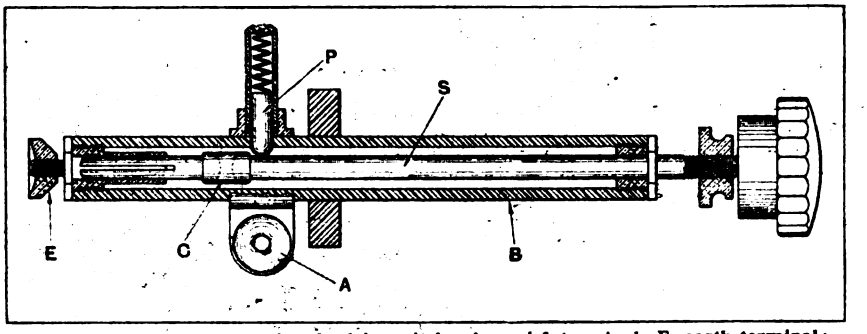
These pot coils are available for many of the well-known makes of loud speakers, and coils can be supplied wound to constructors' requirements. The sample sent in for review and shown in the illustration contains 9lb. of this particular wire, but measures 4½in. in diameter by 4in. long over the insulation, and is designed to fit on to a 2in. core. It is for 6-volt excitation, and since the measured D.C. resistance is 9.8 ohms, it will pass just over 0.6 amp. The price has been fixed at 40s.

"BICO" SAFETY AERIAL LEAD-IN.

This is a combined aerial lead-in and earthing switch possessing the distinct advantage that the switch is totally enclosed and entirely weatherproof. Furthermore, the switch is outside the building, and when in the "safety" position completely isolates the set from the aerial and at the same time connects the down-lead direct to earth. The action is simple but effective. A hollow ebonite tube ½in. in diameter (outside) is fitted with a brass spindle divided by an insulating collar in such a manner that when the spindle is pulled out the aerial is connected, *via* a spring-controlled plunger, to the earth lead. On pushing in the spindle the insulating collar rides over the plunger and connects the aerial to that portion of the spindle to which the lead to the aerial terminal of the set is connected.



Section through "Bico" safety lead-in switch. A, aerial terminal; E, earth terminal; P, plunger; S, spindle; C, insulating collar and B the barrel.

The aerial down lead is taken to the terminal which contacts with the plunger, while the earth lead joins to the terminal on the outside end of the tube; a lead from the "E" terminal of the set goes to earth in the usual manner.

These safety lead-in tubes are available in three sizes: 7in. long at 3s. 6d., 9in. size costs 4s., and 12in. tubes are 4s. 6d. The makers are the Burner Insulator Co., "Bico" Works, 51, Wellington Street, Woolwich, London, S.E.18.

GRAMOPHONE PICK-UP CHARACTERISTICS.

Methods to be Adopted in Presenting Results of Forthcoming Laboratory Tests.

READERS will remember that in the special Gramophone issue of March 6th this year we gave figures for most of the pick-ups then on the market, showing the voltage output at a few representative frequencies. While these figures were useful as an indication of the general character of the output and as a means of estimating the degree of amplification required, they were not sufficiently detailed to disclose resonances and, as was mentioned at the time, could not be taken as a final criterion of performance.

It is now proposed to give complete characteristics plotted from readings taken at small increments of frequency from 100 to 8,000 cycles. The standard frequency records specially prepared by the Gramophone Company, Ltd., will be used, and these will enable readings of output to be obtained at approximately 80 points over the range of frequency already mentioned.

The records provide frequencies down to 25 cycles per second, but experience shows that it is impracticable to give readings below 100 cycles. As is well known, the amplitude of the groove, for a given A.C. output, is much greater at low than at high frequencies; the amplitude is, in fact, inversely proportional to the frequency. In ordinary records it is necessary to restrict the amplitude of notes below about 250 cycles in order that the vibrations may be contained within the standard pitch of the groove. In the standard frequency records, however, a special pitch has been employed for the lower frequencies in order that the correct amplitude may be attained. Only pick-up devices of special design are able to follow the groove, and most of the commercial electromagnetic pick-ups jump the groove below 100 cycles, some even below 200 or 250 cycles.

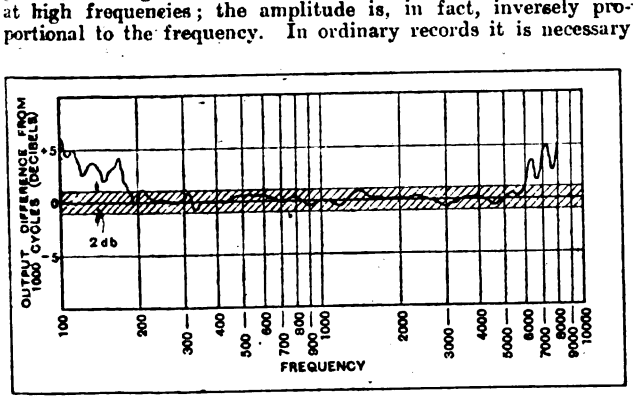


Fig. 1.—Hypothetical curve of gramophone pick-up showing variation of output in decibels (transmission units) taking the output at 1,000 cycles as the standard of reference.

While every effort has been made in preparing the standard records to obtain strict proportionality between amplitude and frequency, it is only to be expected that slight discrepancies have crept in. These deviations from the correct amplitude have been carefully measured and tabulated by the Gramophone Company. The amplitude of the 1,000-cycle note has been taken as the basis of comparison, and differences in the output at other frequencies have been expressed in decibels [1] (transmission units). This suggests a very convenient method of plotting the pick-up characteristic.

If we take the voltage output from the pick-up at 1,000 cycles as our standard and express the outputs at all the other frequencies as differences (either positive or negative) in decibels from the 1,000-cycle standard, it is quite a simple matter to correct for discrepancies in the records merely by adding or subtracting the correction factors supplied with the records. The curve would then take the form shown in Fig. 1. It will be observed that the zero line passes through the curve at 1,000 cycles, and that where the curve appears above the zero line an increase of output above normal is indicated.

Unfortunately this method of presentation does not give any indication of the absolute value of the voltage output, but it has many points in its favour. For instance, we know that the ear is incapable of detecting differences of sound intensity of less than 2 decibels. Thus, if we cover the general trend of the curve with a band 2 decibels wide, small irregularities due to minor resonance will pass undetected by the ear, provided they fall within the limits of the 2-decibel band.

[1] For a full discussion of this unit see the note on page 74 of the July 24th issue.

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Gramophone Pick-up Characteristics.—

The output from the ideal pick-up should fall within the limits of this band from about 250 to 4,000 cycles. Below 250 an increase in the output is desirable to compensate for the restricted amplitude of low notes in the average record. Up to 4,000 cycles we are concerned with the fundamental frequencies of musical instruments, and it is essential that the trend of the curve up to this point should be horizontal. The region above 4,000 cycles is responsible for the overtones, and consequently the timbre of the fundamentals lower down the frequency scale. Assuming a perfect amplifier, it would seem desirable for the curve to continue horizontally to the upper limit of frequency. Many practical amplifiers suffer from high-note loss, so that a slight upward trend above 4,000 cycles would seem to be indicated. Few electromagnetic pick-ups, however, are capable of producing this increase at high frequencies, and here it would seem necessary to modify the amplifier to suit the pick-up.

When the curve is plotted with output voltage against frequency, the irregularities are exaggerated, as will be seen by comparing Fig. 2 with Fig. 1. The general form of the curve is, however, the same, and it is possible to estimate the performance by inspection, bearing in mind that a change in output of 25 per cent. is approximately equivalent to 2 decibels. After careful consideration we have decided that the voltage output curve is the more useful of the two methods of presenting the results. The R.M.S. voltage at the terminals of the pick-up is a tangible quantity which can be visualised by the beginner as well as the expert, and useful information can be obtained with regard to the type of valve and grid bias to be used in the first stage of the amplifier. Those who prefer to work with the decibel unit can easily convert the voltage readings by using the formula $D = 20 \log \frac{V}{V_{1000}}$, where D = output difference in decibels, V = voltage output at any given frequency, and V_{1000} = voltage output at 1,000 cycles.

The voltage curves form a fairly reliable guide to the grid bias required for the first amplifier valve. For instance, let us suppose that the highest point of the curve is 2.0 volts R.M.S. The peak value of the voltage will therefore be $2 \times \sqrt{2} = 2.83$, which must be covered by a bias of -3 volts. Actually the general level of the output from the average record is about half that of the standard frequency records, but in view of the presence of peaks and transients it is best to take the amplitude of the frequency records as the basis for estimating the grid bias.

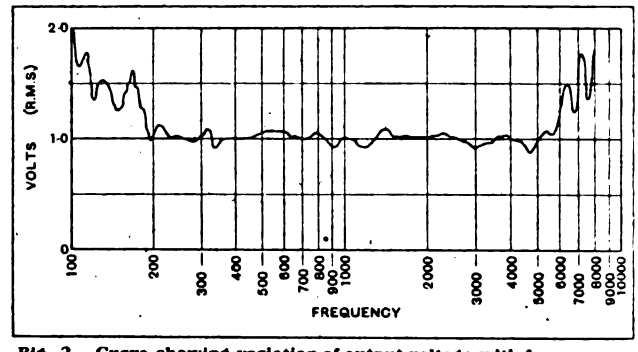


Fig. 2.—Curve showing variation of output voltage with frequency. The readings correspond with the curve of Fig. 1, but it will be observed that the peaks are more pronounced.

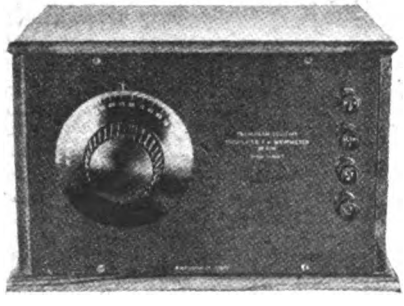
The level of the output is governed to a certain extent by the type of needle employed in the pick-up. Unless otherwise stated, the voltage readings for the curve will be taken with a Tungstyle needle, and a few readings with other needles may be given in order to demonstrate the effect on the output.

The series will be inaugurated in the "Laboratory Tests" section next week with the B.T.H. pick-up.

SCREEN-GRID MODULATED C.W. WAVEMETER.

The McLachlan Wavemeter in which the Calibration is Independent of the Valve.

THE steady demand for long range receivers shows that the fascination in trying to identify foreign stations is not waning. How many listeners have a knowledge of more than one or two foreign languages? Yet how many are prepared to guarantee the identity of a station basing their statement on mere



The wavemeter is extremely compact—

speculation? The modulated wavemeter under review affords a ready means of either identifying unknown stations or finding the correct setting on a receiver for the reception of a distant station the wavelength of which is known.

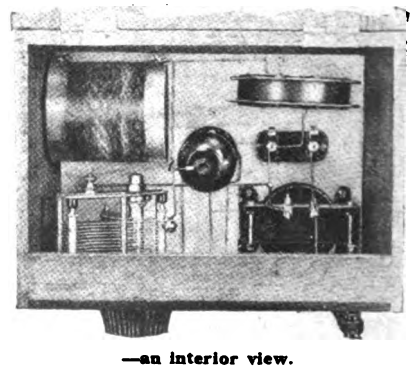
This wavemeter operates on a new principle, use being made of the inherent negative resistance property of the screen-grid valve. In the anode circuit a coil and variable condenser tuned to the radio frequency are connected in series with a suitably proportioned audio-frequency circuit. Two different oscillations are generated and a tuning note is radiated, i.e., the instrument is a miniature broadcasting station.

The tuning note is heard in the loud speaker so that a receiver can be accurately tuned to any wavelength without the aid of an incoming transmission. This instrument has the great advantage that the calibration is independent of the valve, and furthermore neither reaction coil nor heterodyne oscillator are required. The meter can also be used to heterodyne an incoming carrier, zero beat being obtained when the musical note is purest.

Sharp Tuning.

When tested we found that the tuning of the wavemeter was sharp, and that no frequency change took place when the anode voltage was varied between 30 and 70, while maintaining the screen at 100 volts. A two-volt screened valve was used and a variation of filament volts between 1.9 and 2.1 caused a negligible change in frequency. Thus the contention that the calibration is independent of the valve is well borne out in practice. The plate, screen and filament current for the screened valve can be derived from the batteries feeding the receiver.

The instrument is supplied with three coils and three calibration charts embracing the band from 100 to 1,600 kilocycles (3,000 to 180 metres), and sells at £4 15s. (screen-grid valve extra).



—an interior view.

Those desiring an instrument designed along these lines but of great accuracy for precision measurements can obtain special valves in which the anode-to-screen-grid capacity has been reduced from the usual 10 or 12 $\mu\mu$F to about 3 $\mu\mu$F. The makers of the wavemeter are Messrs. H. W. Sullivan, Ltd., Leo Street, Peckham, London, S.E.15.

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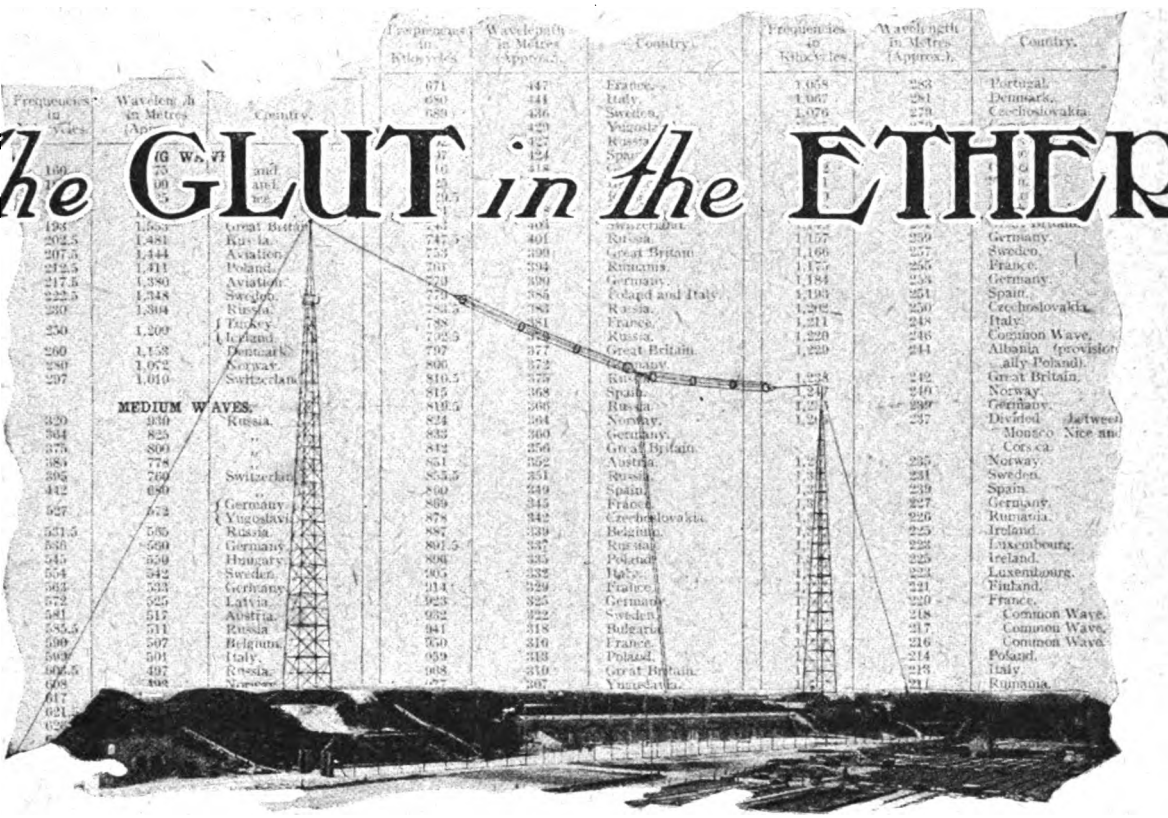
The GLUT in the ETHER



Problems of an Overstocked Waveband.

By J. GODCHAUX ABRAHAMS.

TO-DAY, if we examine a list of European broadcasting stations, we find that, excluding Russia, they have reached a total number of close on two hundred transmitters. In view of the fact that the wavebands allowed to broadcasting are strictly limited, and cannot comfortably include all these stations, is it surprising that the average amateur, when endeavouring to tune-in individual transmissions, should often find himself confronted with an unpleasant mixture of heterodyne whistles and groans, or a background of insistent morse?

Is your set entirely to blame when an attempt to tune-in foreign stations brings in an unsolicited chorus of shrieks and groans? The author of this article would say "No," contending that the European ether is overstocked with stations and that the efforts made by the various authorities to distribute wavelengths evenly over the available band have led to the preferential treatment of certain countries, with results which can benefit none.

It seems probable that the wavelength shuffling to which the authorities have resorted at the Geneva, Brussels and Prague Conferences can prove but a feeble attempt to alleviate a painful situation which must needs grow worse as further stations are erected, or, alternately, as the power of some of the transmitters is increased. Although much has been written with regard to the minimum frequency separation necessary to obtain a more or less satisfactory reception of a number of individual transmissions, it has never been made clear for what reason the stations in Europe have gradually reached so high a number. Was this step justified in all countries? On what basis were calculations made to warrant the erection of extra stations once an initial broadcasting service had been established?

The writer has prepared a tabular survey of the European broadcasting systems, which will show at a glance the relative areas of the various states in thousands of square miles, the number of transmitters actually in operation, the exclusive wavelengths individually allotted to the respective countries, according to the latest *Plan de Prague*, and, finally (where the information is available), the percentage of registered listeners to total population.

What are the factors to be taken into consideration if the claims put forward by a country for the erection of transmitters are to be judged on their merits? If a satisfactory verdict is to be given, we must study the area of the state, its total population, and its actual requirements in respect to a broadcasting service.

Admittedly it is not an easy matter to work merely on this data, for in certain instances it may be necessary to make special concessions, inasmuch as, although a particular country, according to these factors, would be entitled only to a small number of stations, the question

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The Glut in the Ether.—

of diverse languages would necessarily influence a decision. Belgium, for instance, possessing some seven and a half million souls, and covering an area roughly equal to that of Yorkshire, is endowed at present with six broadcasting stations (of which one only can be officially recognised) and has been allocated three exclusive wavelengths; yet, if statistics are to be believed, the country boasts of 2.6 registered listeners per one hundred head of population! The reorganisation of Belgium's broadcasting system under State control will give her one dual- and one single-wave station to enable broadcasts to be carried out in French, Flemish and German, the last-named language for the sole benefit of a limited number of listeners in the Eupen and Malmedy districts, forcibly ceded to her by Germany at the end of the Great War. The case of Belgium is cited as an example; here the claim to a third exclusive wavelength is but weakly justified.[1]

Geological conditions also may alter our basic factors, as in the case of Switzerland, where high mountains considerably restrict the range of the transmitters. Here we register a population of four million people in an area of approximately 1,600 square miles. The proposed reorganised system calls for two high-power transmitters at Sursee and Moudon, and a series of smaller stations (Basle, Berne, Lausanne, Zurich, and Geneva), to which are to be added relays at Olten, St. Gall, Sitten, and Chur. Possibly for the benefit of the Tessin district, in which the inhabitants speak only Italian, a further station will be erected at Locarno, Lugano or Bellinzona.

EUROPEAN STATES.

Country.	App. Area in 1,000 sq. Miles.	Transmitters Working.	Exclusive WLs (Prague Plan).	Percentage of Licences to Population.
Austria	31.75	5	2	5.7
Belgium	11.5	6	3	2.6
Bulgaria	49	—	1	—
Czecho-Slovakia	54.5	4	5 (plus 1 shared)	1.9
Denmark	15	2	2	7.6
Esthonia	18	1	1	1.1
Finland	150	5	3	2.2
France	213	27	16	2.3
Germany	182.2	28	13 (plus 1 shared and four on loan)	4.6
Great Britain and N. Ireland	95	20	10 (plus 1 free)	6.0
Greece	40	—	1	—
Holland	12.8	2	2 (plus 1 borrowed)	1.7
Hungary	36	1	2	2.0
Iceland	41	1	Shared	—
Irish Free State	26.5	2	2	0.8
Italy	120	6	7	0.1
Jugo-Slavia	248	3	3 (plus 1 shared)	—
Latvia	41	1	1	1.2
Lithuania	20	1	Taken from upper band	0.6
Luxembourg	1	1	1	—
Norway	124	10	5	2.4
Poland	150	5	8	0.7
Portugal	55.5	1	1	—
Roumania	160	1	3	0.2
Russia	1,492	60 (roughly)	21	0.1
Spain	197	9	6	0.5
Sweden	173	30	6	6.6
Switzerland	16	5	5	1.9
Turkey	10	1	Shared	—

Except where otherwise stated, the above table does not take into consideration wavelengths which are common to two or more countries. It should also be noted that such extra-European stations as Algiers, Rabat and Angora do not appear in the Prague list.

Surprising Figures

The latest statistics show that broadcasting in Switzerland has appealed to only 1.9 per cent. of the total population. Observe, however, that five exclusive wavelengths have been granted to that country: it is apparent that a number of transmitters will be compelled to share waves.

Austria, on the other hand, as the table shows, is almost three times the size of Belgium, and her population is over six millions; she possesses five transmitters, but only two exclusive wavelengths have been allotted to her. Yet her percentage of registered licence holders reaches the astonishing figure of 5.7.

If we turn to Poland, we find that, although she now has five stations working for a population of twenty-seven millions, eight exclusive waves have fallen to her share; yet only 0.7 per cent. of her inhabitants are interested in radio programmes!

In passing, it may be mentioned that of all European countries Denmark is the one which has shown the most enthusiasm for broadcasting, for, with a population of about three millions spread over an area of approximately fifteen thousand square miles, 7.6 per cent. of the inhabitants are registered licence holders. At the Prague Conference Denmark secured two exclusive wavelengths; but, as the slogan adopted there is "fewer stations, higher power," it seems that, in one country at least, a solution has been found to the problem of giving everyone an efficient service.

The more the table is studied the more difficult is it to understand on what basis the distribution of wavelengths was carried out, for there seems little doubt that some countries have received preferential treatment.

Take France, a newcomer to the European Broadcasting Union, which may now dispose of sixteen exclusive wavelengths, whereas Italy, not far short in population, is allotted only seven!

Moreover, the grievances expressed by Dutch listeners would appear to be justified, for to Holland the authorities have allotted two wavelengths, namely, 1,875 metres, to replace the nominal 1,852 metres hitherto used by Huizen, and 298 metres in the middle waveband.[2] Huizen is a comparatively new arrival on the ether; not only was it erected several years after Hilversum had organised a regular broadcasting service, but it was originally destined to work on short waves. What, then, must become of Hilversum if it is no longer allowed to operate on 1,071 metres, seeing that this wavelength has been given to Norway? Is Hilversum to be closed down, or must her trans-

[1] Since this article was written the National scheme has been rejected by the Belgian Parliament, and for the present no reorganisation can take place. Belgium, therefore, has withdrawn its request for the third exclusive wavelength.—[Ed.]

[2] The Dutch Ministry of Transport has allocated the wavelength of 1,875 metres (allotted to Holland) to the Huizen *transmitter*, and 1,071 and 298 metres to the Hilversum *transmitter*. As 1,071 metres has been given by the *Plan de Prague* to Norway, from January 1, 1930, Holland will lose this wavelength. The arrangements regarding the use of the two Dutch stations by the various programme associations do not concern this article.

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The Glut in the Ether.—

missions be buried in the full-to-overflowing medium broadcast band, namely, on 298 metres? The Dutchmen consider that their plea of unfairness is justified, inasmuch as the *Plan de Prague* has comfortably housed Kalundborg, which, again, is of comparatively recent establishment.

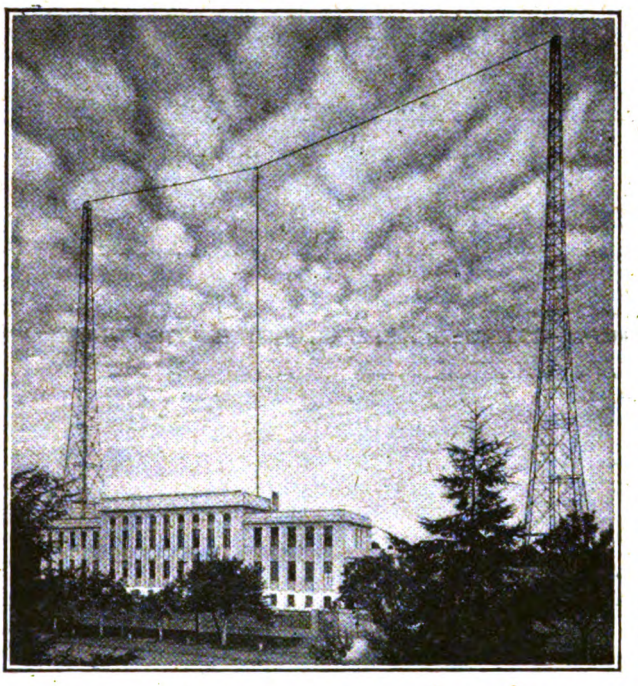
"Pioneer" Prerogatives.

With regard to Great Britain and Germany, the only conclusion to be drawn is that, as these countries were pioneers of broadcasting in Europe, and obviously, first in the field, they were given every opportunity of choosing both the number and position of wavelengths desired. It is true that both countries have made concessions as and when they were needed for the benefit of Continental countries generally, but the number of exclusives retained by these two "pioneers" still seems out of proportion to their requirements. Can it be that their demands are based on the assumption that the bulk of listeners still own simple crystal sets capable only of receiving local transmissions? It would be difficult to obtain accurate statistics in Great Britain to-day regarding the increased use of valve receivers, for our licences from the outset have made no distinction as to the class of apparatus installed by the listener. It may be assumed, however, that the steady growth in the number of valve receivers sold monthly indicates that the more primitive crystal is being replaced. Also, the considerable increase in the popularity of multi-valve portable receivers in most European countries demonstrates that the average wireless enthusiast is not content to derive all his programmes from the local station. This being the case (and trade figures undoubtedly supply the necessary confirmation), the more extended use of valve sets has enlarged the effective working range of broadcast transmitters, which are then able to cover districts *beyond those for which they were primarily erected*. Moreover, the extra energy with which some of these reconstructed transmitters have been endowed has also added to their efficiency, and without doubt, if a careful revision were made, based on the new conditions, it would be found that a number of stations in many countries may be considered superfluous.

As improvements in both radio circuits and valves have been made, so the smaller and more convenient frame aerial has gradually replaced the unsightly outside "clothes-line," again reducing the number of crystal owners. Generally speaking, it will be found that the more primitive receiver is found only in densely populated cities in close proximity to a broadcasting station.

If all classes of the community are to be satisfied, we have but two alternatives; either it is necessary to install a large number of relay stations of strictly limited power for the use of listeners who will not forgo their small crystal sets, or two or three super-power transmitters must be erected to radiate programmes which can be received at much greater distances by owners of more expensive valve apparatus.

It would seem that the only way in which European broadcasting can be extricated from its present congested state is by a drastic pruning of what can be termed unnecessary growths; the number of transmitters possessed by individual states must be reduced to reasonable proportions commensurate with the service they are called upon to give to their listening population.



ONE OF THE TWO HUNDRED. Breslau, a well-known German broadcaster operating with 4 kW. on a wavelength of 253 metres.

Practical experiments in Germany and Great Britain show that several low-power relay stations can be made to work on a common wavelength, providing their frequency can be accurately maintained, without any risk of mutual interference. If, therefore, the need for a relatively large number of small transmitters actually exists in a country, more use should be made of the *onde commune*, the stations taking their programme from a central studio which, for obvious reasons, would in most instances be situated in the capital. Such reorganisation of the broadcasting system in many lands would release a corresponding number of exclusive waves, and by so doing might permit a greater frequency difference between higher-powered stations, and thus reduce the interference trouble.

This step, in conjunction with the weeding-out of superfluous units, would lead to a healthier condition of the European ether.

NEXT WEEK'S ISSUE

will contain constructional details of a High Tension eliminator for D.C. mains, in which a special filter circuit is employed. The unit will meet the requirements of those having 3-, 4- or 5-valve sets and will deliver a current quite free of ripple even from the "roughest" of mains.

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Broadcast Brevities

NEWS FROM ALL QUARTERS.

By Our Special Correspondent.

Tatsfield Receiving Station.

A few weeks ago I said that the new B.B.C. receiving station at Tatsfield might be ready this month, but now learn that it will not be brought into service until the middle of September, when all the gear at present used at Keston will be transferred to Tatsfield—broomstick aerial and all.

oooo

Also Brookman's Park.

I should not be surprised if the regional station at Brookman's Park is radiating a regular service about the same time, and it will probably have a fairly smooth passage for two or three months until the twin-wave transmitter is brought into service, when troubles may arise for a time. So complicated has become the aerial system of suburban villadom that some of us are likely to be more or less incommoded by a next-door neighbour who is not content to settle down to one or other of the programmes for any length of time, but restlessly switches from one to the other every two minutes.

oooo

The Footpath Story.

While on the subject of Brookman's Park, I understand that a lot of ink has been spilt unnecessarily on the subject of the alleged closing of a certain footpath near the new station. The facts of the case appear to be that the B.B.C. is making a new concreted path for the benefit of foot passengers, but the old short cut remains open to those who wish to save about four yards and do not object to mud on wet days.

oooo

The S.O.S. Season.

Some amusing stories are going around about the sudden increase in S.O.S. broadcasts, and provincial journals have been indulging in flights of imagination. One writer, referring to this subject, cites a case of a "straying uncle" who was "tracked down to the Norfolk Broads in less than half an hour" and "returned in time to assist at a family wedding, resigned but a little sad."

In case listeners should think that any wandering uncle can be found in this way it may be as well to state that the only circumstances in which S.O.S. calls are undertaken by the B.B.C. are :—

(1) Missing persons—only broadcast at the request of the police.

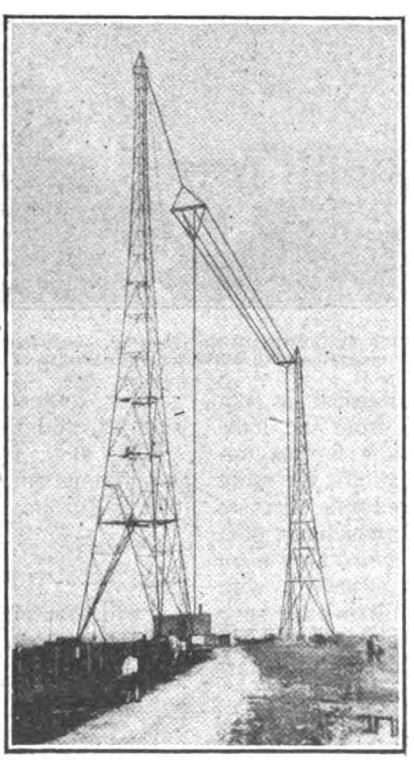
(2) Messages to trace relatives of persons dangerously ill—only broadcast when illness has been confirmed by the medical authority attending the case and after all other means of communication have failed.

These hard facts rather mercilessly destroy the romance of the "missing uncle."

oooo

Western Regional Station.

Our Celtic compatriots of the Principality of Wales are already impatiently demanding a regional station for themselves, but I fear they must await their turn, and even then will probably have to share the Western station with their neighbours in Somerset, Devon and Cornwall. I understand that this is fourth on the list of projected regional stations. The original order proposed was, Northern England, Southern England, Scotland and the West, arranged as far as possible to satisfy the needs of the greatest number of listeners in the shortest possible time, but as those in the South suffered more from interruption by ships' traffic in the Channel the southern station was considered more urgent than that in the North of England, and was given precedence.



The masts and aerial system of the Danish broadcasting station at Kalundborg, from which the Copenhagen programmes are broadcast on a wavelength of 1,153 metres.

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The Northern Station, a Correction.

A correspondent in the *Huddersfield Examiner* takes me to task and corrects the pronunciation, given in these notes on August 7th, for Slaithwaite which, he says, should be "Slawit" and not "Slewitt." I accept the correction with thanks, the more so as his letter drew from another correspondent the story of a Colne Valley manufacturer who was endeavouring to impress on an incredulous fellow-traveller from London to Huddersfield the correct pronunciation of the locality. "Well," said he, "when we get there I will ask the porter, and you will hear for yourself." On arriving he called to the porter, saying, "Hey, porter, what station is this?" The porter replied, with a merry twinkle in his eye and to the discomfiture of the questioner, "Why, damn thee Joss, tha knows!"

oooo

Talks for the Coming Season.

One or two new features will appear in the Talks which the B.B.C. is now arranging for the months of September to December. The tendency of the times under the general title of "Points of View" should lead to some witty comments by such eminent speakers as Dean Inge, Sir Oliver Lodge, Mr. H. G. Wells, Prof. Haldane, and Mr. G. Lowe Dickinson, the author of "A Modern Symposium."

Another series, on the lines of "My Day's Work" which was broadcast some time ago, will be entitled "While London Sleeps." These are to be given by night workers such as a journalist, a river policeman, a Covent Garden porter, and a coffee-stall proprietor. A series of portraits of personalities, real and imaginary, called "Miniature Biographies" are also contemplated, the contributors including André Mourois, Virginia Woolf, and Harold Nicolson.

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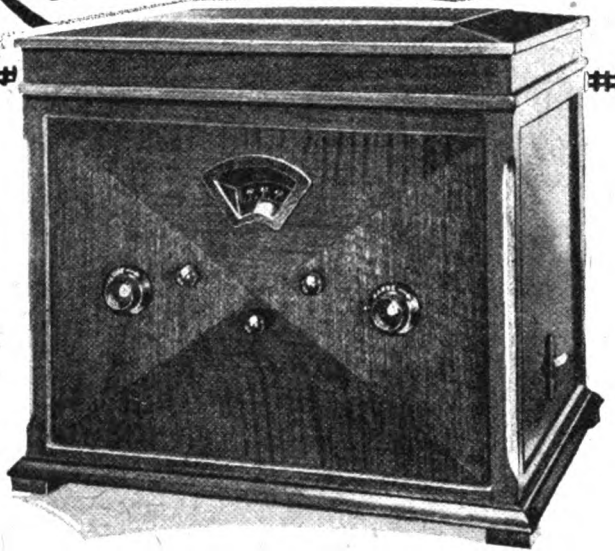
Broadcast Receivers (RI) ALL-ELECTRIC S.G. THREE



Without an Aerial—
An Ideal Set
for the
Flat Dweller.

With an Aerial—
A Sensitive
Long-range
Receiver.

WHEN indirectly heated A.C. valves, and, in particular, the AC/S screen-grid valves, made their first appearance it was realised that their effect on domestic receiver design would be nothing less than revolutionary. In the first place, they offer a complete solution of the problem of battery maintenance, and, secondly, their amplifying efficiency is such that a single stage, either of H.F. or L.F., is more than equal to the two-stage H.F. and L.F. amplifiers hitherto found to be necessary for long-distance or frame-aerial reception.

Messrs. Radio Instruments, Ltd., have not only realised the potentialities of these new valves, but have already produced a complete design for the coming season in which the many problems peculiar to these valves have been successfully solved.

Compactness and Elaborate Screening.

The All-electric Screened Grid Three is really a dual-purpose receiver. It can be used without an aerial for the B.B.C. transmissions, and, as such, may be regarded as an ideal instrument for the flat dweller. Provision is made, however, for the attachment of an outside aerial, and when this is done the receiver is at once converted into an instrument of exceptional power and range. Having regard to the fact that the equipment includes a battery eliminator the dimensions of the cabinet are extraordinarily compact. Measuring only 12¾in. × 16¾in. × 15in. the set can be transported from room to room and used wherever a lighting or power point is available.

Compactness, however, calls for a careful layout of components, and in the R.I. set there is an elaborate system of screening which effectively suppresses any tendency to instability. The whole of the detector stage is enclosed in a copper box surmounted by a detachable aluminium cover plate. The L.F. valve, though not the output transformer, is also housed in this compartment, both valves being removable through holes in the aluminium plate. The aerial circuit and screen-grid valve are mounted outside the copper screening box, but are sheltered by the aluminium top plate which covers the whole area of the inside of the set. The AC/S valve projects through a hole cut in the top plate and is completely enclosed by a detachable flanged cover. The aluminium cover plate is held down by quickly detachable screws giving easy access to the interior of the screening box. Valves can be changed, however, without disturbing any part of the screening other than the flanged cover over the AC/S valve.

It is interesting to note that no attempt has been made to avoid capacity coupling between the aerial and loud speaker circuits. Indeed, coupling has been deliberately introduced in order to take advantage of the loud speaker leads as a short antenna when working without an outdoor aerial. That this arrangement does not produce instability is a tribute to the manner in which H.F. currents have been kept under control after the detector stage.

The simple but effective parallel-feed tuned grid circuit is used to couple the H.F. valve to the detector. The H.F. choke used in the anode circuit of the screen-grid valve is the R.I. Dual Astatic Choke which was specially developed for use in this type of circuit. It has the special merit of being free from absorption bands on the lower broadcast wavelengths.

The tuning condensers of the aerial and H.F. circuits are mechanically coupled, giving one main tuning control. A small compensating condenser is provided as an auxiliary control to bring the two circuits exactly

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R.I. All-electric S.G. Three.—

in step at any part of the tuning range. Considerable attention has been given to the question of aerial coupling, and a method has been developed which enables any aerial or no aerial at all to be used without throwing the difference between the tuned circuits outside the range of correction of the compensating condenser.

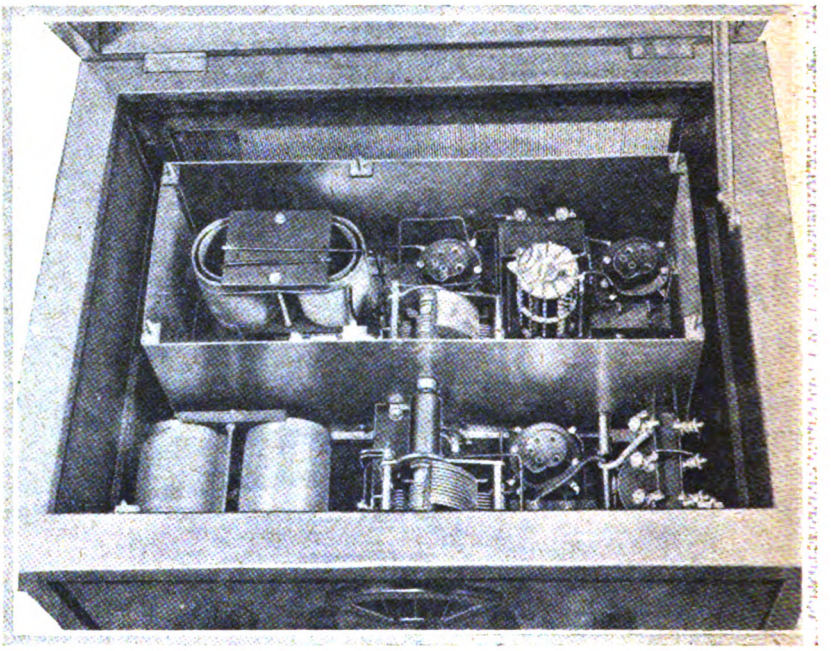
Leaky grid detection is employed, and reaction is applied to the tuned grid circuit through the usual combination of magnetic and capacity coupling. The detector is an AC/G valve, and is coupled to the AC/R output valve through an R.I. "Hypermu" transformer. The loud speaker is fed through an output transformer.

Effective Ripple Filter.

There is abundant proof that considerable time has been devoted to the development of this circuit. As evidence in support of this we would mention that grid bias is derived from the H.T. circuit by means of resistances connected between the valve cathodes. This somewhat difficult problem has been successfully solved, and the set performs with a negligible trace of hum, quite inaudible during reception. The elimination of the grid bias battery greatly simplifies the maintenance problem and limits replacements to the valves, which should function without attention for years.

In connection with the mains unit itself, it is only necessary to mention that the smoothing condensers are much above the usual size. Regulation porcelain fuses are fitted in each main lead, and a quick-break porcelain switch is fitted in the right-hand side of the cabinet. Adequate ventilation is provided by the perforated back of the cabinet. The rectifier is a half-wave SP41U valve.

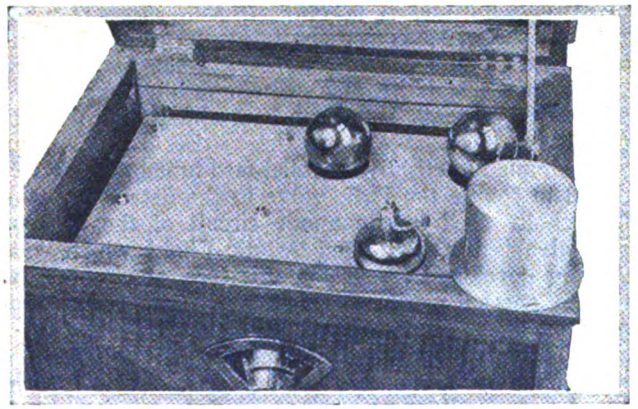
In spite of the apparent multiplicity of controls (there are in all five knobs on the front panel) tuning is not a difficult process. Once the function of the controls has been mastered from the instructions their manipulation becomes instinctive. The reaction control is smooth and free from backlash, and maintains its setting over large sections of the dial both on long and short waves. The main tuning control has just the right reduction gearing, and the compensating condenser covers all settings of the main tuning control irrespective of the type of aerial employed.



Interior of the screening box with aluminium top plate removed.

The high quality of reproduction and low level of residual mains hum create at once a favourable impression on first switching on the set. No doubt the use of only a single stage of L.F. amplification contributes largely to the high standard of quality obtained. The volume available is sufficient to work any of the more efficient moving-coil loud speakers, and, in order to do justice to the quality to be obtained from this receiver, a loud speaker of this type is to be recommended.

Tests of range and selectivity were carried out 20 miles north of London, the receiver being first of all tried out without any external aerial system. No difficulty was experienced in tuning-in 2LO, 5GB and two foreign transmissions at good loud speaker strength on the lower waveband, while at least eight other stations were also picked up, though at a somewhat lower volume level. On long waves, Radio Paris, Königswusterhausen, 5XX, Eiffel Tower and Hilversum were well received, and no difficulty was experienced in separating the first three of these stations. In our opinion the selectivity without an aerial will be more than sufficient to give adequate separation of the alternative programmes from Brookmans Park when that station comes into operation.



The valves are readily accessible, the H.F. valve being screened by a detachable metal cover.

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R.I. All-electric S.G. Three.—

When an aerial is connected to the set the selectivity suffers to a certain extent, probably on account of the special aerial circuit connections which have been adopted. Whatever the cause, the background from Daventry 5XX, with a 40ft. aerial, extended 20 degrees on either side of its normal setting, and involved both Königswusterhausen and Radio Paris. On the short waves, 5GB spread 8 to 10 degrees, and 2LO six degrees, but the range was phenomenal. No attempt was made to count the stations received on the lower waveband, and it is no exaggeration to say that it was impossible to tune to any part of the dial without encountering a station. With an efficient outdoor aerial there is more sensitivity than the average man requires, and some of this can be well spared in the interest of selectivity. The obvious solution is to reduce the length of aerial until a compromise is reached which satisfies local conditions.

It is, however, as a self-contained receiver, without external aerial or earth, that the All-electric Screened Grid Three earns special commendation. The quality is good, the set can be moved from room to room, and there are no batteries to maintain, while the sensitivity and selectivity are sufficient to guarantee several alternative programmes at all times.

The makers are Messrs. Radio Instruments, Ltd., 12, Hyde Street, New Oxford Street, London, W.C.1, and the price of the receiver, inclusive of all valves and royalties, is £30.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS.

Sir,—May I please be allowed to join myself with the expressions of opinion of "An Observer" appearing in this week's *Wireless World*?

I, as one of the old officials of the Incorporated Radio Society of Great Britain, feel that the amateur has only himself to praise or blame for his present position.

Anybody listening to many amateurs' transmitters cannot fail to be impressed with the fact that many of them are of the "change the needle o.m." type. Others are obviously merely sending calls in the hopes of collecting those foolish QSL cards. The cards in question are harmless enough, but when the collector is known to have applied for and obtained his licence on the grounds of experiment, it is small wonder that the status of the amateur is harmed by this practice.

Another point is that some of them do not even observe the regulations under which they hold the licence. A case in point is that of the transmitter heard less than four weeks ago, who said over the ether that he had not a wavemeter. As a matter of fact, he was off the amateur band of wavelengths and apparently did not know it, and had not the means of ascertaining his position. His correspondent did not enlighten him, so presumably he also was working by guesswork.

The recently published letter of Mr. Bevan Swift makes clear the part taken by the amateur or his representatives in concluding the agreement under which transmitting licences are now granted. I remember full well that the R.S.G.B. got all that could be had from the Postmaster-General. I also recollect that that Department was very attentive and courteous in its dealings with the R.S.G.B. It seems clear that no further facilities could be obtained without interfering with other and perhaps more important services. If the amateur treats his hard-earned concessions so lightly he can hardly expect to improve his position in the future.

To get back to the original point under discussion, it seems that the R.S.G.B. is being criticised by a few who, for various reasons, are not satisfied with their facilities. To do this in the public Press is an admission of a lack of *esprit de corps* which is deplorable. If the amateur hopes to improve his status and gain additional facilities, the pleas of the QSL collectors and those who want radio purely as a "lark" must be disregarded. The amateur has in the past done splendid work on the rocky path of pioneering. The pioneer days are over and we know to whom the credit for good work is due. Increased knowledge and everyday application of high frequency work makes the way of the amateur more exact and demands more of him than it used to do. If he wishes the word amateur to mean the same as it did he must keep pace with the times.

There is no reason why amateurs should not still consist of a body of enthusiastic, keen and jolly companions with wireless as the binding material, but to me it seems that public outpouring of criticism against the parent society and incidentally the oldest wireless society in the world, cannot assist him to attain this end.

ASHTON J. COOPER.

Ilford, Essex.

Sir,—May I be permitted to comment upon the question of amateur status? Your leading article in July 24th issue seems to imply that the Radio Society of Great Britain should still be considered as the premier organisation for the amateur. This raises a rather awkward situation. The Association of British Radio Societies, as Mr. Gill, the secretary, and Mr. Hartley said in their correspondence to you, published on July 17th, came into being due to lack of policy of the R.S.G.B., since which time the Association has acquired a very large membership, and without taking too much credit for the Association, I submit that they have done many things for the amateur, and taken up the cudgels on the amateurs' behalf very effectively with the authorities. At the same time I do appreciate the possibility of amalgamation and unity in the organisations existing for the benefit of the amateur.

If the R.S.G.B. would realise that the majority of their membership, and, if I may say so, the stout props of their organisation, are in the provinces, and will decentralise sufficiently to give the lie to the feeling that the R.S.G.B. is still the London Wireless Society, there would be no question of opposition. I say if they would do this guardedly, because, candidly, I think it impossible. They also think this, and came to the conclusion some seven years ago when they instigated the grouping system whereby local organisations banded together, and were self-governed, but were to rely upon the parent organisation for advice and help.

You have received letters from various people pointing out that this advice and help was not forthcoming; in fact, opposition was created. May I take you back to the time the Manchester Radio Scientific Society established an experimental station? Several genuine experiments were carried out with microphone and amplifiers. These experiments were cut short due to the interference of the P.M.G., and although the R.S.G.B. were advised of the position they flatly refused to give any assistance, and I believe an important member of the R.S.G.B. was more or less responsible for the P.M.G. inflicting impossible restrictions on the Society in question.

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The Association of British Radio Societies does intend to contest every injustice inflicted on the amateur movement, and is trying its best to live up to its national title, and is ready at any time to sink its own individuality, I am sure, into any organisation which can be created for the benefit of the amateur in general, but as it would appear that the A.B.R.S. have a greater membership than the R.S.G.B. it does not appear reasonable to expect the A.B.R.S. to give all up to an organisation which has already proved and admitted failure to provide for the amateur movement.

Might I suggest that, through your paper on some suitable occasion, such as I think, the Manchester Wireless Exhibition, a conference is organised at which the whole of these matters may be thrashed out. For your information I may tell you that the annual general meeting of the A.B.R.S. is being arranged to take place during the Manchester Wireless Exhibition, and a programme of events such as the annual dinner, visits to various works, and places of interest are being arranged. It occurs to me that, with the aid of your journal, this might be made the occasion for a national conference, attended by all the organisations with the power to agree to any scheme most suitable to the majority. The Association of British Radio Societies, I feel sure, will be only too pleased to co-operate in any scheme for the benefit of the whole.

Manchester. J. E. KEMP, Chairman,
The Association of British Radio Societies.

Sir.—I hope that the subject of amateur status, so ably championed in your editorial columns, will provide thought for British transmitters, and that some effort will be made to free us from many of the restrictions now in force.

I am sorry to see that the A.B.R.S. is taking advantage of this opportunity to do some propaganda work for their organisation, and, what is not in the amateur spirit, some propaganda against the R.S.G.B.

I have been an active transmitter since 1925, but such is my ignorance that I had never previously heard of the A.B.R.S., and, judging from the spirit of their official letter, I am not likely to join.

"Fed-up G Ham" sums the position up very nicely, but I cannot allow Mr. Jamison's letter to pass without a comment. He does not tell the whole story of his relations with the R.S.G.B. Sufficient is it to say that Mr. Jamison appealed to the Radio Transmitters' Union (N. Ireland) for support in his dealings with the R.S.G.B , and his fellow transmitters, after considering the case, did not give their support. Mr. Jamison has resigned from the R.T.U.

If amateurs are to improve their status they will need to be a united body and speak with one voice. They are too few to have several strong societies, apart altogether from the undesirability of such a condition in amateur radio.

The R.S.G.B. is not perfect; but, in my opinion, it has done great work for British amateur transmitters, and is the recognised national Society. As such, it is the obvious medium for any organised effort to improve the amateur status, and I have always had consideration and courtesy from the executive members, of whom I have a very high regard.

In conclusion, may I express my appreciation of the way *The Wireless World* is assisting the amateur?

T. P. ALLEN, M.Sc.
Belfast. Radio GI6YW.

WHAT THE A.R.R.L. THINKS.

Sir.—Just a line to offer you our congratulations for your editorial on "Amateur Status" in the issue of July 10th. We think it very splendid indeed. A. L. BUDLONG.
Asst. to the Secretary.

The American Radio Relay League,
Hartford, Conn., U.S.A.

ELECTRONIC OR ELECTROLYTIC?

Sir,—We note in a recent letter that readers are invited to discuss the meaning of electronic and electrolytic action, and that the Westinghouse metal rectifier is referred to in connection with this.

As the manufacturers of the Westinghouse metal rectifier we would like to give our views on the subject.

Your correspondent states that "an electrolytic action is surely the evidence of an electron flow." This is not in agreement with the usual views, which are that electrolytic conduction is carried out by the positive and negative charges on the dissociated ions of the electrolyte travelling through it in opposite directions from one electrode to the other. The medium between the electrodes must therefore be a chemical compound which readily dissociates into electro positive and electro negative ions, the electric charges on which depend on the relative numbers of protons and electrons forming them, i.e., the arrangement of their chemically combined electrons.

Electronic conduction on the other hand means that the passage of electric current is simply a flow of free or uncombined electrons. The difference between a conductor (metals in general) and a non-conductor is that the first has in its molecules free electrons, which do not affect it in a chemical sense, and which can readily pass from one molecule to the next and so form a flow of electric current.

In the special case of the thermionic valve there is no conducting medium in the space between the electrodes, but by heating one of them and applying a P.D. across them the free electrons in the heated electrode will leave its surface and pass across to the other, thereby forming a flow of electric current.

The same reasoning appears to apply to the Westinghouse metal rectifier, with the exception that no heating is necessary, and accordingly the claim of electronic action as opposed to electrolytic action would seem to be fully justified and in no sense confusing.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL CO., LTD.
J. H. PETER, General Manager.

Sir,—A letter in *The Wireless World* for August 7th from Mr. L. Clarke contains a statement which requires some modification.

It was there stated that an electrolytic action was evidence of an electron flow. Such is certainly not the case. Electrolytic action is evidence of ionic flow. Free electrons are not involved in the changes inside the cell during, say, the electrolysis of copper sulphate. However, in metallic conduction, that the phenomenon is due to free electrons and not to ions is proved by the absence of diffusion of the conductors at the junction of two dissimilar metals in a circuit carrying a current. When the Westinghouse rectifier is said to be electronic in action, what is meant is that there is no ionic flow across the oxide-copper junction and therefore no diffusion of the oxide into the copper or of the copper into the oxide.

Rectification would then be due to the fact that electrons either could pass in one direction only, as in the thermionic valve, or could pass in one direction more easily than in the opposite. However, I should like to know how it was shown that the action is electronic rather than electrolytic; perhaps some of your readers can supply me with the references.

As far as conduction in crystals goes, there is some evidence to show that a conversion of ions does occur in a few cases across the crystal-metal junction. F. LLEWELLYN JONES.
Glamorgan.

TRANSMISSION QUALITY.

Sir,—There is a certain portion of the activities of the B.B.C. the excellence of which is taken too much for granted. People talk about the wonderful reproduction of their sets now that they have installed the latest thing in receiving sets and loud speakers. But it never seems to occur to such people that their set is merely a link in the chain. For if the transmissions of the B.B.C. were not so very nearly perfect it would be quite impossible to reproduce good speech and music, however good the amplifier and loud speaker. This fact hardly seems to be realised at all by a great many people, and I think it is a fact for which the B.B.C., who have spent so much time and trouble improving their apparatus, should get due praise. AN APPRECIATIVE LISTENER.
London. W.2

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READERS' PROBLEMS

"THE WIRELESS WORLD" SUPPLIES A FREE SERVICE OF TECHNICAL INFORMATION

The Service is subject to the rules of the Department, which, are printed below; these must be strictly enforced in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Fluctuating Eliminator Output.

I gather that the terminal voltages of an eliminator are always more or less dependent on the current consumed by the valves of the receiver. Should it not be possible so to arrange matters that the voltage delivered is practically independent of current consumption? If so, I should be glad of a hint as to how this state of affairs might be realised. M. V.

It is a fact that the voltage output of all eliminators is more or less dependent on load; in fact, in some of the best designs, where separate feeds are provided for the various valves through series resistances, voltage fluctuations are greater than in the case of comparatively simple instruments with a potential divider.

An eliminator, either for A.C. or D.C. mains, can be designed in such a way that its voltage output is almost unaffected by the load within practical limits, but such an instrument would be unduly expensive, and, moreover, it would be extravagant. This is because the only practical way of satisfying your requirements is to feed each terminal through a potentiometer of such a low resistance that it consumes a current many times greater than that taken by the valve (or valves) fed from it. As you are probably aware, potentiometer feed for anode bend detectors and screening grids has been advocated by writers in this journal; when dealing with low consumption circuits, it is easy to ensure that the potentiometer will consume much more current than the load without making the device unduly extravagant, but this is impracticable when arranging to feed, say, a super-power valve, or even an ordinary power valve.

oooo

Actual Anode Voltage.

Will you please describe a simple method of measuring the actual voltage on the anode of the output valve of my set? I wish to apply the maximum voltage permitted by the makers' instructions (150 volts). I am sending you a circuit diagram of the receiver; will you please mark on it the connections of the measuring instrument? It should perhaps be added that I have a combined H.T.-L.T. meter rated at 200 ohms per volt. A. M.

We see from your circuit that the output valve has a milliammeter permanently connected in its anode circuit, and that this valve is provided with a separate filament rheostat. This simplifies the task of taking an actual voltage measurement. All you have to do is to connect a voltmeter directly between anode and negative filament of the valve in the manner shown in Fig. 1. Previous to doing this, you should make a note of the current indicated by the plate milliammeter under normal working conditions with full filament brilliancy. When the

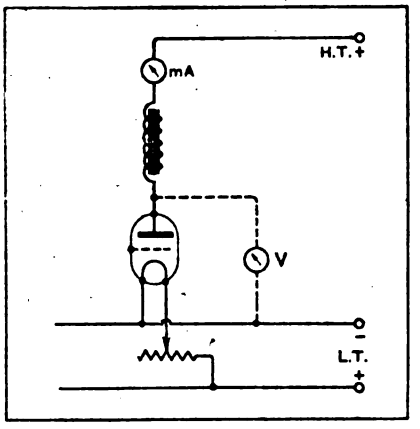

Fig. 1.—Measuring the voltage actually applied to an anode.

voltmeter is connected, it will be observed that the milliammeter reading will increase slightly, due to the presence of a resistance (that of the voltmeter) in parallel with the valve. The next step is to decrease filament emission by operating the rheostat until the milliammeter shows its original and normal reading, when the pressure indicated by the voltmeter will be that actually on the anode under working conditions—with the voltmeter removed, of course.

In cases where a filament rheostat for the output valve is not fitted, a variable resistance may be temporarily connected in the lead between the set and the positive L.T. accumulator terminal.

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A Partial Cure.

Since installing an eliminator for my receiver I have been troubled a good deal with motor-boating and L.F. oscillation. I am told that the addition of a choke filter output arrangement will effect a cure. Do you agree? C. N. L.

This statement is rather too sweeping; although there can be no doubt that a properly arranged choke filter device will reduce the tendency towards L.F. oscillation it cannot be assumed that it will provide a cure in every case.

We think, however, that you would be well advised to try it, but you must make sure that the circuit adopted is that in which one side of the loud speaker is connected to "earth." If the trouble is not cured, we suggest that you write again, giving details of your set.

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Poor H.F. Amplification.

(Referring to previous letter) . . . . You say that my trouble is almost certainly associated with the H.F. stage; I find that when the H.F. valve is switched off, signals from the local station which are normally quite good are almost completely eliminated. In fact, as far as reception of this station is concerned, the valve seems to work quite well. Do you think that the fact that its inclusion makes such a great difference to signal strength is a proof that the valve and its associated circuits are free from blame? R. S. G.

We observe from your address that you live less than fifteen miles from the London transmitting station; at this distance it is quite impossible to form an opinion as to the effectiveness of an H.F. stage when listening to the local signals. In any case, your test is by no means conclusive, because when the valve filament is switched off, the detector grid circuit is more or less isolated from the aerial, being linked to it only by stray couplings.

The near-by station will provide a more useful source of testing signals if you use but a few feet of aerial wire during your efforts to localise the trouble.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Testing a Two-stage H.F. Amplifier.

The performance of my two-stage transformer-coupled H.F. amplifier is far from satisfactory. After having improved the screening and added decoupling devices, complete stability has been attained, but sensitivity is much less than it should be; judging by previous experience, I should rate it as no better than that of a good single-stage amplifier. Will you please give me a suggestion as to how to proceed in making a stage-by-stage test, preferably without dismantling much of the apparatus, as some of the connections in the screening boxes are not too accessible? E. A. W.

Provided a logical method of procedure is adopted, there is not much difficulty in making a thorough test of two H.F. stages, and you should find it easy enough to trace the exact cause of the trouble. As a first step, we recommend that you should test the second H.F. stage and the detector; this can very simply be done by disconnecting the first H.F. of the anode from its coupling transformer, and in its place joining an aerial to the primary winding. If the aerial is of full size, a small condenser of about 0.0001 mfd. should be interposed.

Under these conditions the set will be functioning as a single H.F.-det. combination, and the reception of good signals will indicate that detector and H.F. valves, and also the second H.F. transformer, are functioning properly. It will also be suggested (but not definitely proved) that the first H.F. transformer is correct. While conducting this test the normal aerial-grid tuned circuit will not be in operation, and its variable condenser should be set at minimum capacity, or, at any rate, "off tune."

Before proceeding with further tests it would be wise to interchange the H.F. valves, noting whether signal strength is the same when the valve normally used in the first position is transferred to the second socket.

As a next step, after having decided that the second stage is working well, the aerial should be put back to its normal terminal, and it should be observed whether, with both H.F. valves operating, signals are of greatly increased strength. If they are not, it may safely be assumed that the fault is located in the input aerial-grid coupling, the connections to the first valve (but not the valve itself), or, just possibly, in the primary winding of the H.F. transformer.

To make a comparative test of the first H.F. stage as compared with the second, it will be necessary to break the second and third grid circuits at the points marked X in Fig. 2, and to add bridging connections as shown in dotted lines. With this form of connection the second H.F. valve is completely eliminated, and a test can be made of the aerial coupling arrangements, the first H.F. valve, the first H.F. transformer, and the detector. It should be added that this last test is generally unnecessary if the procedure detailed above has been carried out, and that it may occasionally give misleading results unless the necessarily long detector grid circuit leads are carefully disposed.

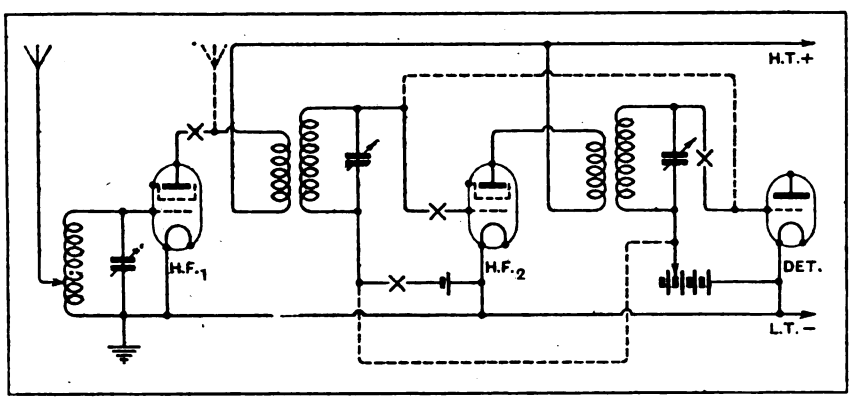

Fig. 2.—Stage-by-stage tests of a 2-valve H.F. amplifier.

H.F. Transformer Design.

Guided by your recent articles on the subject of H.F. transformer design, I have rewound the primary of my intervalve coupling in order to match the comparatively high impedance of my H.F. valve. Although amplification is distinctly improved, I find that the setting of the neutralising condenser does not hold good over the whole scale. This is not very serious, as instability is only evident on the lowest condenser settings; a more serious trouble is that selectivity is appreciably reduced. Will you make a suggestion as to how this can be improved? N. M. D.

Regarding your neutralising difficulties, it is only to be expected that it will be more difficult to obtain a balance when maximum amplification is reached, and we think that this trouble will easily be overcome by decoupling the circuits, and possibly by adding a little more screening than is customarily included in a set of this sort. We can well believe that the falling off in selectivity will be more troublesome; it should be made clear that the articles dealt with the subject from the aspect of maximum amplification, and it is a fact that the realisation of this ideal must inevitably be accompanied by some falling-off in selectivity. Unless you can make your aerial coupling arrangement more selective without impairing its effectiveness, your only course, we fear, is gradually to remove primary turns until the best compromise between long range and freedom from interference is reached.

o o o o

The Screening Grid Voltage Problem.

With a view to making an accurate measurement of the voltage applied to the screening grid of my H.F. valve from an eliminator, I have obtained a moving coil voltmeter rated at 1,000 ohms. per volt. One would imagine that a high-grade instrument of this sort should give an accurate reading, but yet it does not appear to do so. I have come to this conclusion because the set gives definitely better results when this circuit is fed, as a temporary measure, from a dry battery. Do you think that my meter is suitable for this purpose? L. W. S.

It is safe to say that no instrument of the type you are using, however good, is to be relied upon as an indicator of the actual voltage applied to the screening grid—at least, unless it is used in a very special manner. This is because the current consumption is often very low, sometimes falling below that passed even by a meter of exceptionally high resistance.

For further information on this subject and for instructions as to how accurate measurements may be made we would refer you to an article in our issue of January 16th.

o o o o

Zero Grid Rectification.

Due to the proximity of the transmitter, my "local station" set has a large reserve of amplification, and in order to reduce overloading and in an effort to improve quality, I have fitted a low-impedance detector valve (anode bend method). The negative bias for this valve was set at 9 volts, but results were not good; I have just discovered that signals are appreciably louder when the detector grid circuit is returned to negative filament—with the bias battery completely out of circuit. I cannot understand why the detector should rectify best with no bias, and should appreciate your comments. R. W. D.

In the absence of definite information as to the characteristics of your valve, we must assume that with 9 volts negative bias it is working more or less on the straight part of its grid volts/anode current curve, and consequently there is little rectification. When the valve is operated with a zero grid, considerably more rectification will be taking place, due to the effect of grid current, and we think that this explains your difficulty. It seems certain that the valve needs considerably more than 9 volts negative for proper detection.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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THE B.B.C. "HUSH-HUSH" STATION.

BROOKMAN'S PARK, the firstfruits of Captain Eckersley's regional scheme, is now ready for service, and its inauguration should be, for British broadcasting, the most important event since the establishment of the B.B.C. The regional scheme has now been a topic of conversation for some two years since the plan was first put up by Captain Eckersley, and it can be said that it constitutes the first definite step in the establishment of a permanent scheme to provide alternative programmes throughout the country. Seeing, then, that the inauguration of transmissions from this station is an event of prime importance, why is it that the B.B.C., in its behaviour with regard to the station, is acting as if the station were something to be ashamed of, and to be brought into existence with as little commotion and as much secrecy as the B.B.C. can ensure? No definite date is given, we are told, for the station to commence work, but it is hinted that the station will gradually slide into use so that the public will all at once wake up to the realisation that a second station is providing regular alternative programmes for the inhabitants of the London area.

Why all this secrecy and caution in putting the station into operation? If the engineering staff were scared lest the station should prove a failure, then we might understand this reticence, but, knowing the staff, we have no reason whatever for doubting that the station of their design will be efficient as a transmitter.

Confidence of the Public.

We know that criticism of the regional scheme has been very general, but we had come to the conclusion that the B.B.C. had been able to live down the criticism and had by now restored the confidence of the public in the potentialities of the scheme. So far as we ourselves were concerned, we were content, in view of the assurances which the B.B.C. had given, to wait for the station to begin operation rather than to continue any criticism of a pessimistic nature. Our only criticism had been because we believed that selectivity in excess of that provided by the circuits of practically all crystal sets and a very large proportion of the valve receivers at present in use, would be required within a large radius of the station in order to avoid the "swamping" effect of the high power of the two transmissions.

We would have thought that the inauguration of Brookman's Park as the first station of the regional scheme would have been the occasion for extreme jubilation on the part of the B.B.C., the listeners, and the wireless industry. We should have expected that the opening of the station would have provided a first-class opportunity for publicity for broadcasting generally, and that the inauguration would have been a ceremonial affair in keeping with the importance and dignity of the occasion.

Make the most of it.

It is not now too late for the B.B.C. to revise its plans for the opening of Brookman's Park, and we would urge the Corporation to consider the advisability of abandoning the "Hush-Hush" policy with regard to the commencement of the Brookman's Park transmissions, and letting the occasion be one where no stone will be left unturned in ensuring the utmost publicity possible for British broadcasting. The opening ceremony would then take place just prior to the National Radio Show at Olympia, and assist very largely in focusing public attention on broadcasting and its value to the community at a most opportune moment.

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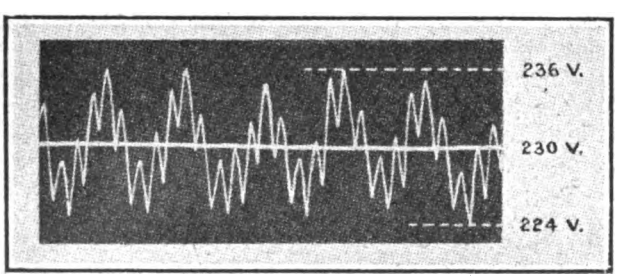
HUM PROOF D.C. ELIMINATOR

A High Tension Unit with a Double Filter for Feeding 3-, 4- or 5-Valve Sets from the "Roughest" of Mains.

By W. I. G. PAGE, B.Sc.

ALTHOUGH the conversion of supply mains from direct to alternating current proceeds apace there are still a large number of districts where the change has not yet been made, and where a comprehensive D.C. eliminator which can immediately be modified for A.C. would be welcome. An examination of the title illustration will show that the eliminator about to be described is contained within a metal safety box so designed that opening the lid causes all connection with the mains to be severed and all metal parts to become "dead." On the right is the filter itself, and on the left the L.T. accumulator for the receiver can be placed provided that its overall dimensions do not exceed 8in. × 4½in. × 7in. high. Where the mains have a positive earth connection the accumulator terminals, and probably a film of acid around them, will have a difference of potential to earth of some 200 volts; it is thus a great advantage, in order to prevent shock, only to have access to this component after it is automatically disconnected from the mains. The space taken by the accumulator can be used for the transformer and rectifying equipment, using practically



[Courtesy Messrs. Ferranti.

Fig. 1.—Typical waveform of D.C. supply mains. The peaks of the superimposed ripple in the case of a 230-volt supply might cause a rise to 236 volts and a fall to 224 volts as shown.

the same filter if the eliminator be subsequently wanted for A.C. mains.

Before proceeding to describe the H.T. unit in detail it would be as well to discuss the nature of a typical D.C. supply system for the *raison d'être* of each component part of the filter. In Fig. 1 is seen an oscillogram of a typical 230-volt supply. At the peaks the instantaneous voltage has risen to 236 and dropped to 224, and the superimposed ripple waveform is most irregular. The disturbances are not only a function of the speed of the generator and the number of commutator bars, but also may be due to switching on of heterogeneous gear along the line. If a filter can be designed so that the ratio of output to input ripple voltage is under 0.2 from 40 cycles upwards it would appear from experiment that the very "worst" mains, including most mercury arc systems, can be smoothed to a hum-free anode supply. It is because of the extremely wide frequency band of disturbance which is in direct connection with the filter that the D.C. unit chiefly differs from that for A.C. where the transformer isolates the input.

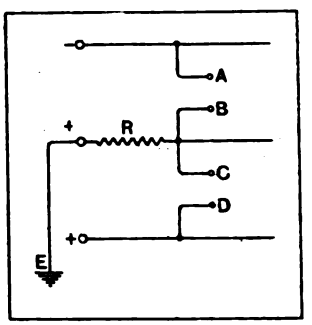


Fig. 2.—The three-wire supply system. The consumer will either be connected to A and B or C and D. Owing to the small resistance R, the neutral lead at the consumer's end may have a difference of potential to earth.

The distribution of D.C. is usually effected by the three-wire system, as shown in Fig. 2. The central neutral conductor is earthed at the generating station, and consumers will either obtain their supply by being connected to A and B or C and D. In one case the negative lead A would have a potential difference to earth of some 200 volts, while in the other case the positive lead D would have a similar potential difference. Since the neutral conductor must have a small resistance R, the many hundreds of amperes passing through it will cause B and C to have a small voltage above the true earth point E.

Earth Condenser Considerations.

If we are connected to A and B, the usual earthing of the negative filament in a receiver connected to the mains will mean a complete short-circuit of the supply,

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Hum Proof D.C. Eliminator.—

If we happen to be connected to C and D, earthing our negative filament will entail a flow of current from the neutral conductor to earth, which is forbidden

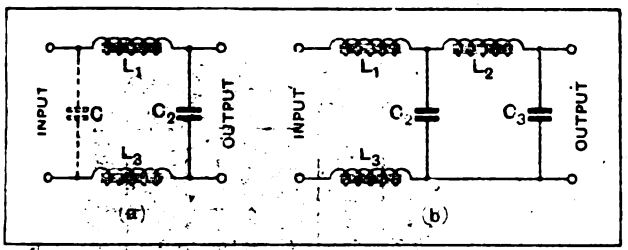


Fig. 3.—(a) A simple filter for D.C. mains. The choke L_3 can often be dispensed with when dealing with a negative neutral. Owing to the capacity of the mains a condenser C (in dotted lines) in the position shown would be useless. (b) A more ambitious double filter necessary when the mains are "rough" and especially useful where mercury arc rectification is used.

under the terms of the agreement with the supply company. It is thus clear that an earth condenser (see C_5, Fig. 5) *must* be included in a D.C. eliminator. With the three-wire system it is possible for a momentary fault to arise at the generating station whereby the plates of the earth condenser may have a potential difference of twice that of the supply mains; the test voltage for this component should therefore not be less than 500.

With a positive neutral conductor (A, B, Fig. 2) there is always a flow of ripple current through the negative lead, and it is for this reason that a choke of high impedance to fluctuating currents and a low resistance to D.C. (because it is in a common return wire) must be interposed. The choke (L_3) employed has an adequate inductance with heavy currents, and its D.C. resistance is only 145 ohms. When testing the eliminator on mains with a positive neutral the omission of L_3 caused quite a serious hum. It may be found that with a supply having a negative neutral L_3 is not necessary. In Fig. 3 (*a*) the simplest D.C. filter is shown; if the mains happen to be reasonably smooth the output after it has passed through the necessary voltage-dropping resistances is probably adequately free from ripple. It should be mentioned that the mains have such a large capacity that a condenser C (in dotted lines) of, say, 2 mfd. shunted across them serves no useful purpose. A more ambitious double filter which is used in the present eliminator is illustrated in Fig. 3 (*b*). Its property of smoothing such rough D.C. circuits as are produced by mercury arc rectification is incomparably better than the circuit of Fig. 3 (*a*) provided that the values of the chokes and condensers in the network are as given in Fig. 5.

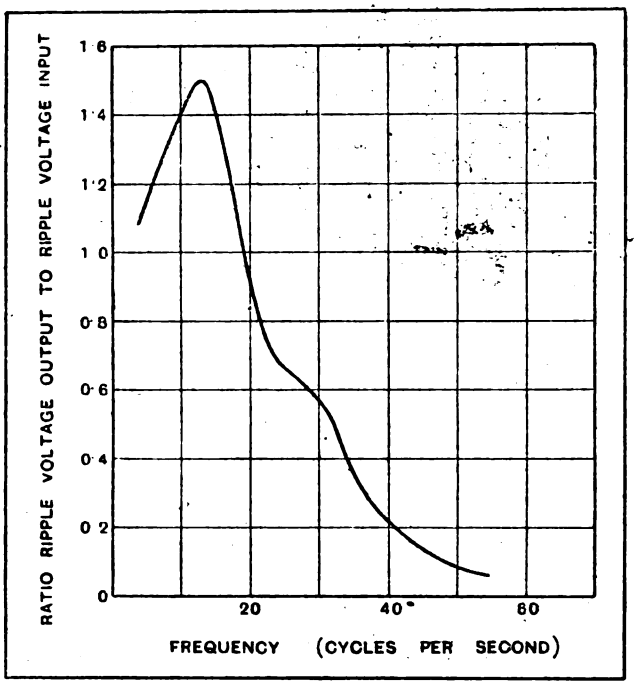
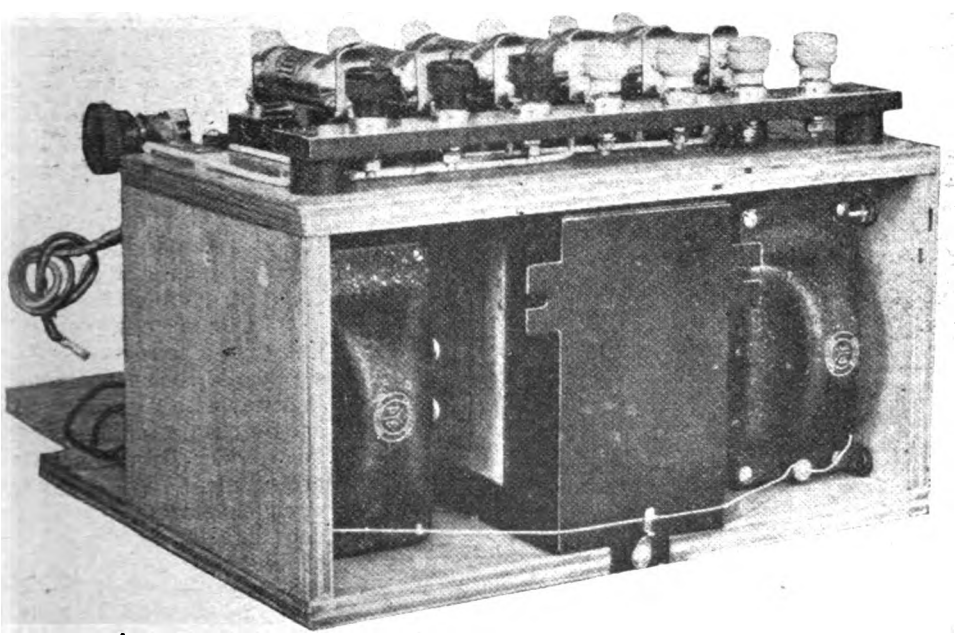


Fig. 4.—The type of curve given by the double filter of Fig. 3 (b). Provided that the peak is below 25 cycles the filter is likely to deliver an output free from ripple.

The effectiveness of the double filter to reduce the amplitude of an applied ripple voltage at various frequencies is given in a typical curve in Fig. 4. Here there is a distinct natural resonance at about 15 cycles, but, as has been



The whole unit can be lifted from the safety box. In the centre is the 19-mfd. condenser block.

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Hum Proof D.C. Eliminator.—mentioned before, provided that above about 40 cycles the ripple output is reduced to less than one-fifth of the ripple input there will probably be no hum heard in the loud speaker. For further details as to the efficiency of various filters reference should be made to an interesting paper [1] by P. R. Coursey and H. Andrewes read before the Institution of Electrical Engineers.

With the exception of the earth condenser C_9 the other seven condensers are in the form of a 19-mfd. condenser block with tappings in the following order: 6, 4, 2, 2, 2, 2, 1 mfd. together with a common terminal. A composite condenser of this design confers the advantage of cheapness and compactness and involves considerably less wiring.

[1] Journal I.E.E., Vol. 65, July, 1927.

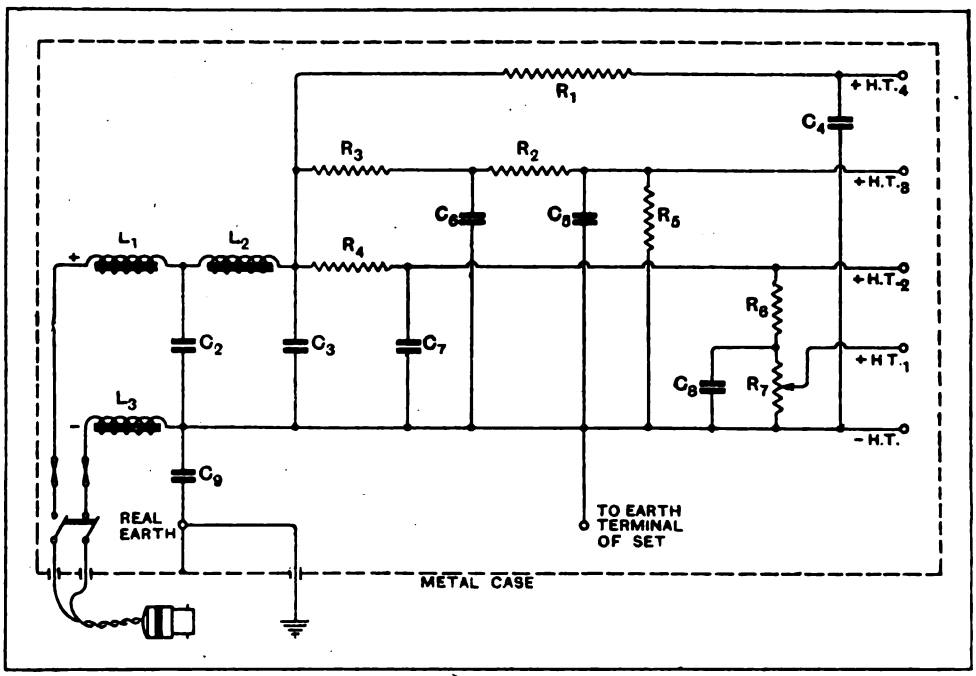
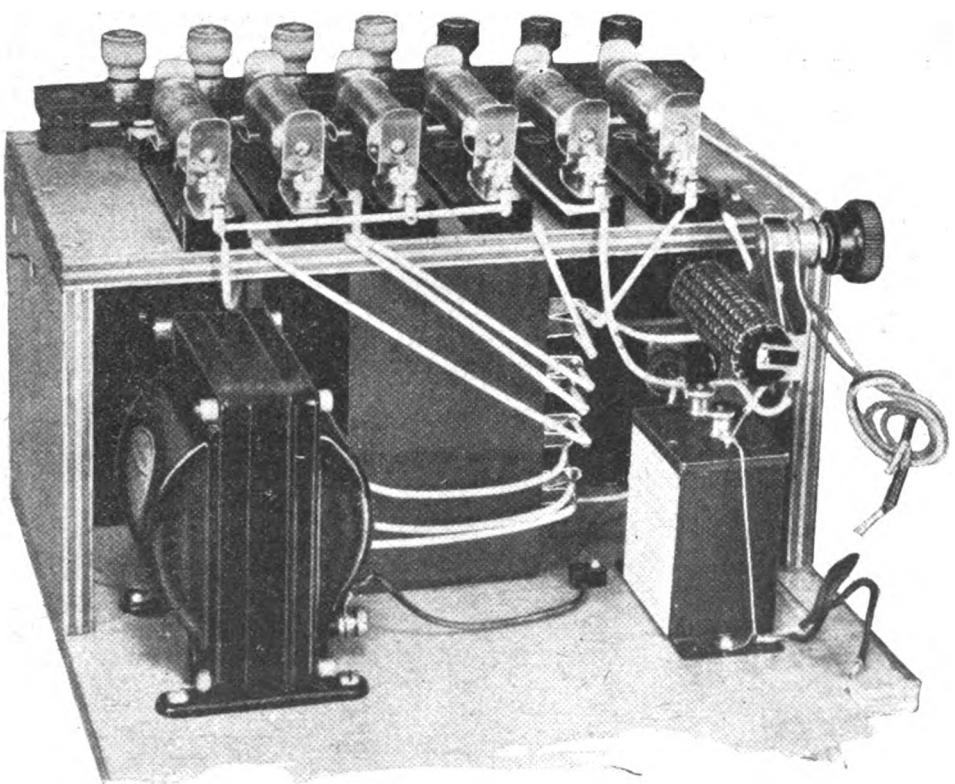


Fig. 5.—The circuit diagram. L_1, 32 henrys; L_2, 20 henrys; L_3, 6·17 henrys; C_2, 6 mfd; C_3, 4 mfd; C_4, 2 mfd; C_5, 2 mfd; C_6, 2 mfd; C_7, 2 mfd; C_8, 1 mfd; C_9, 2 mfd, 500-volt test; C_2 to C_9 (inclusive) are in the form of a tapped condenser block of 19 mfd; R_7, 25,000-ohm wire-wound potentiometer; R_6, 10,000 ohms. When using a typical screen-grid valve followed by a "D" type valve as anode bend detector and a power valve requiring about 20mA. at 150 volts, the other resistance should have the following values when the mains are 220 volts; R_1, 4,000 ohms; R_2, 10,000 ohms; R_3, 10,000 ohms; R_4, 10 000 ohms; R_5, 40 000 ohms.



On the right can be seen the earth condenser above which is the variable wire-wound potentiometer for critical screen voltage control.

The numbers printed on the label attached to the condenser block correspond with the condenser numbers in the circuit diagram of Fig. 5, e.g., C_3 represents the condenser between 3 and "common."

The remainder of the eliminator containing voltage-dropping resistances and condensers calls for little comment except perhaps for the critical control scheme of screen voltage (H.T.+1) for a screen-grid valve if one is employed in the receiver. As is customary a potentiometer is used—in this case a fixed clip-in resistance R_6 being connected in series with a wire-wound 25,000 ohm variable potential divider R_7. Such an arrangement is desirable since movement of the slider does not alter the total value of R_6 and R_7, and thus the regulation of the feed of H.T.+2 (also a potentiometer) is hardly changed. Whilst R_7 serves

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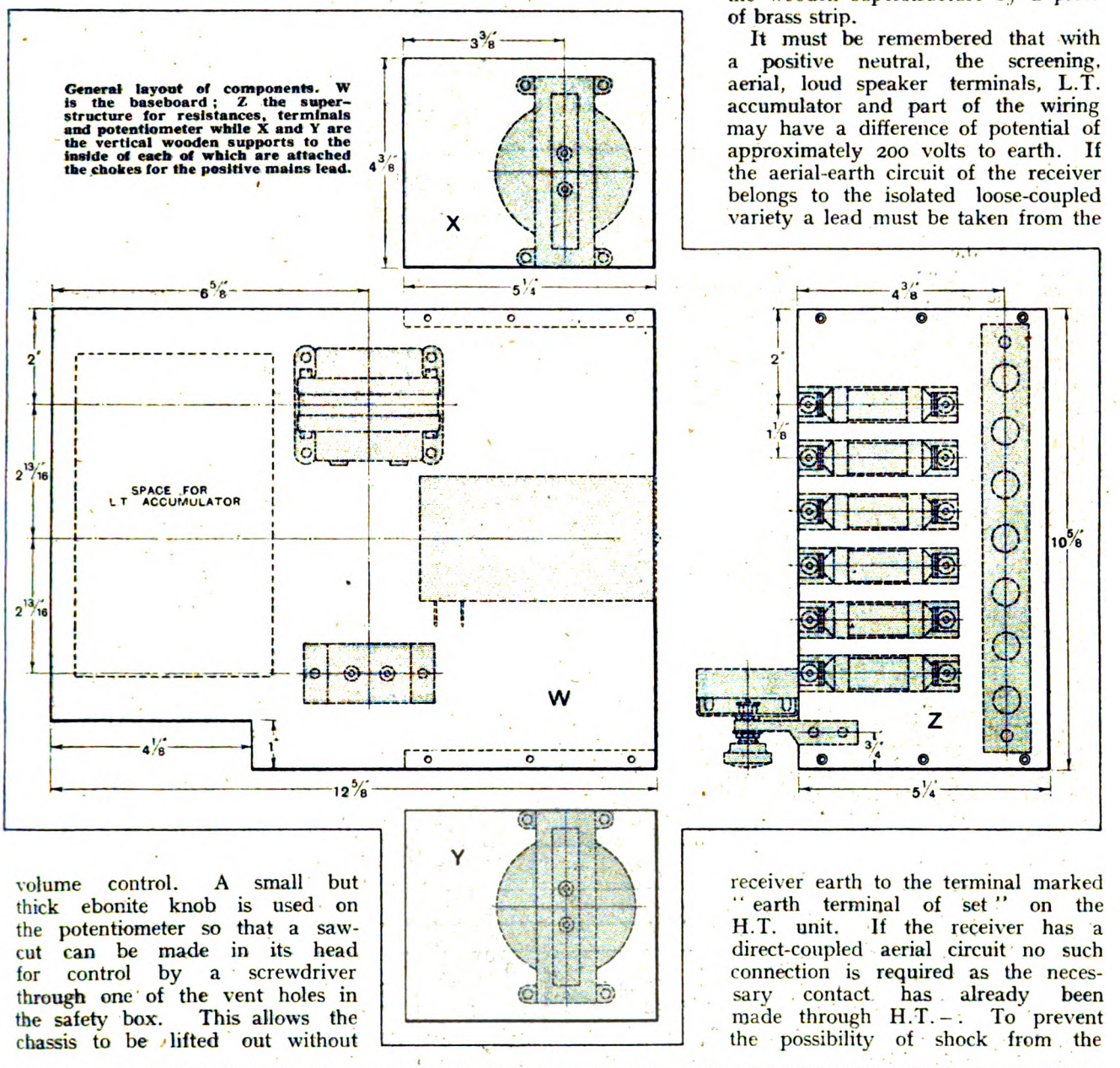
Hum Proof D.C. Eliminator.—

as a critical control of screen voltage for maximum amplification it can also be used as a very effective volume control. A small but thick ebonite knob is used on the potentiometer so that a saw-cut can be made in its head for control by a screwdriver through one of the vent holes in the safety box. This allows the chassis to be lifted out without hindrance and avoids the difficulty of a live spindle passing through the earthed metal cabinet. The potentiometer is fixed to the upper surface of the wooden superstructure by a piece of brass strip.

It must be remembered that with a positive neutral, the screening, aerial, loud speaker terminals, L.T. accumulator and part of the wiring may have a difference of potential of approximately 200 volts to earth. If the aerial-earth circuit of the receiver belongs to the isolated loose-coupled variety a lead must be taken from the receiver earth to the terminal marked "earth terminal of set" on the H.T. unit. If the receiver has a direct-coupled aerial circuit no such connection is required as the necessary contact has already been made through H.T.−. To prevent the possibility of shock from the



General layout of components. W is the baseboard; Z the superstructure for resistances, terminals and potentiometer while X and Y are the vertical wooden supports to the inside of each of which are attached the chokes for the positive mains lead.

LIST OF PARTS.

1 Safety box, 13" × 10" × 7¾" (Ferranti).
1 L.F. choke, 6/17 henrys (B.2 Ferranti).
1 L.F. choke, 20 henrys (Pye).
1 L.F. choke, 32 henrys (Pye).
1 Variable high resistance wire-wound potentiometer, 0 to 25,000 ohms (Electrad-Truvolt, Rothermel).
6 Resistances and holders (Ferranti).
1 Condenser block, 19-mfd. 500-volt test (type BE.46 Dubilier) (6, 4, 2, 2, 2. 2, 1 mfd. tappings in this order).
1 Fixed condenser, 2 mfd. 500-volt D.C. test (Dubilier).
7 Terminals (Tapa).
6 Spade ends (Lisenin).
6 Wire labels ("Coltags," S. H. Collett Manufacturing Co., Ltd., 60, Pentonville Road, London, N.1).
1 Baseboard, 12½" × 9¾".
1 Lampholder adaptor.
Multi-ply wood, 20" × 5¼".
Systoflex, screws, wire, etc.
Terminal strip, 1" × 9" × ¼".

Approximate cost of all parts, £7 5s.

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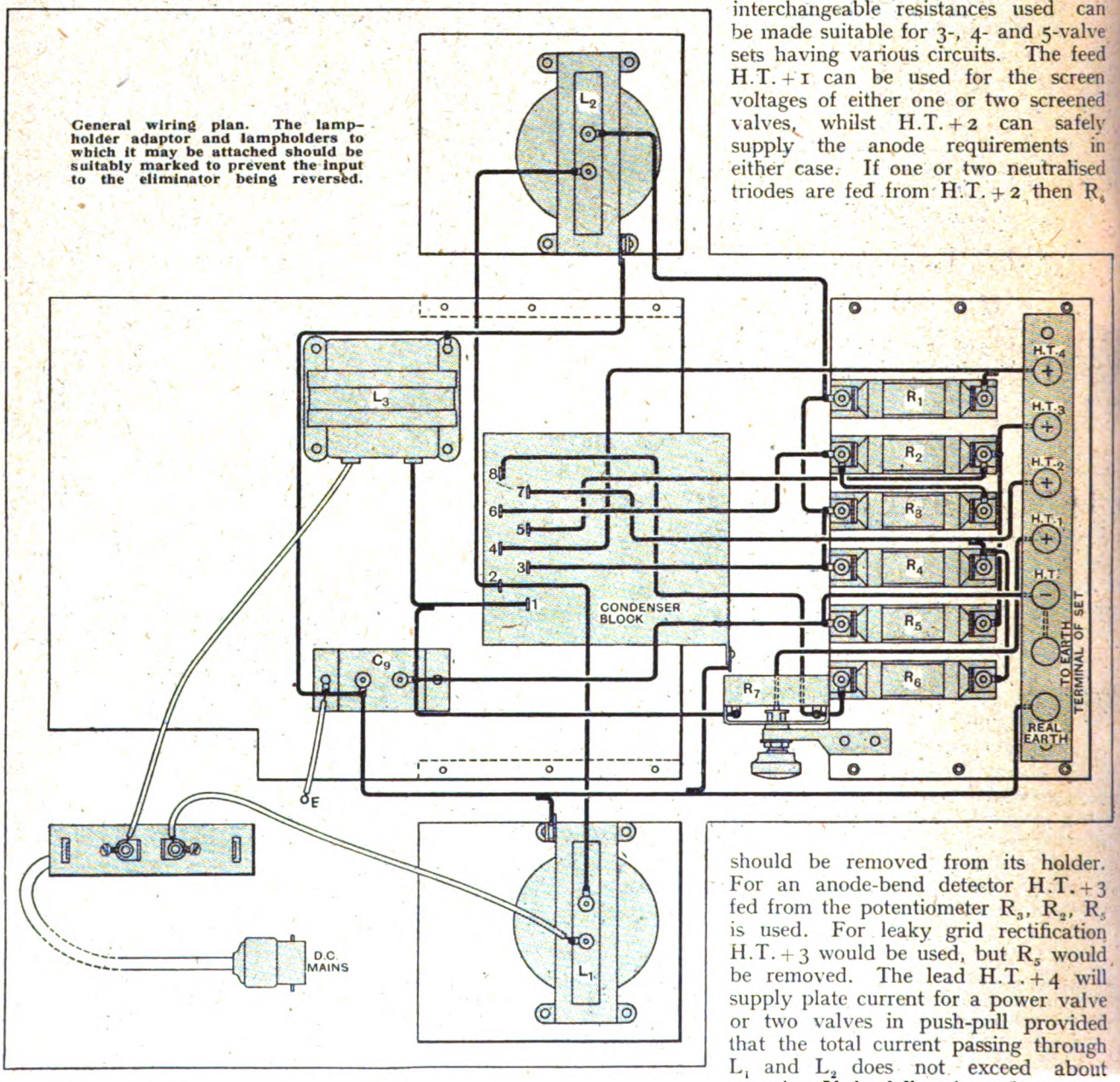
Hum Proof D.C. Eliminator.—

aerial, a series aerial condenser, if not already embodied, should be fitted *inside* the receiver. The loud speaker can be isolated with an output transformer, or, if a choke-filter output is employed, condensers on *either* side of the speaker are necessary. To give absolute immunity from shock the receiver and eliminator should really be housed in one box the lid of which, when lifted, could be arranged to disconnect the mains. Such an elaborate scheme is hardly justified in view of the short life of the remaining D.C. systems in this country.

It should be noted that the safety box is a new model having dimensions as shown in the list of parts. It is earthed, as are also the cases of the chokes and condensers. The fuses in series with the switch in the lid of the box are rated to blow at one ampere and protect the various components in the event of serious overload or short-circuit. A terminal for " real " earth has been arranged on the terminal strip so that the earth wire to be found in the flexible cable from the safety box can be disregarded, and the projecting end together with the metal label cut off.



General wiring plan. The lamp-holder adaptor and lampholders to which it may be attached should be suitably marked to prevent the input to the eliminator being reversed.

The eliminator by reason of the interchangeable resistances used can be made suitable for 3-, 4- and 5-valve sets having various circuits. The feed H.T.+1 can be used for the screen voltages of either one or two screened valves, whilst H.T.+2 can safely supply the anode requirements in either case. If one or two neutralised triodes are fed from H.T.+2 then R_6 should be removed from its holder. For an anode-bend detector H.T.+3 fed from the potentiometer R_3, R_2, R_1 is used. For leaky grid rectification H.T.+3 would be used, but R_1 would be removed. The lead H.T.+4 will supply plate current for a power valve or two valves in push-pull provided that the total current passing through L_1 and L_2 does not exceed about 50 mA. If the full mains voltage (less a small drop due to the chokes) is required for the last stage, R_1 can be removed and a short-circuiting bar put in its place.

It will be seen that separate series feeds are arranged

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Hum-proof D.C. Eliminator.—

for each valve, the only exception to this being in the case of a two-stage high-frequency amplifier where the screens and anodes can be safely fed from H.T.+1 and H.T.+2. It is, of course, assumed that a receiver incorporating such an amplifier would be well decoupled. The filtering scheme between L_2 and the receiver is so generous that separate chokes have not been found necessary in the leads H.T.+4 and H.T.+3.

Owing to the multiplicity of supply voltages and the wide range of anode currents taken by valves it is quite impossible to give any specific values for the resistances R_1 to R_5. Should the amateur possess a milliammeter it is an easy matter to see that the feed currents at H.T.+2, H.T.+3 and H.T.+4 are the same as when the valves are supplied from a battery of known voltage. Failing this, reference should be made to an article by the author entitled "Dropping Volts," in *The Wireless World* of November 28th, 1928. The resistance values given under Fig. 5 are suitable for a receiver such as the "Megavox-Three," but in this case R_5 need not be removed for leaky grid detection.

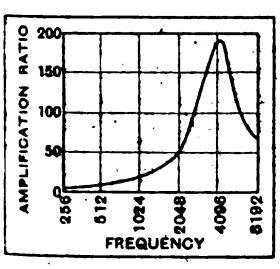
As to performance, the eliminator was tried with various *Wireless World* receivers, and was found to give an output in which no superimposed ripple could be heard even with a moving-coil speaker. A commercial kit set in which very few decoupling devices were included gave no trouble from hum or motor-boating. When the time comes for conversion to A.C. reference must be made to an article under the title "Megavox Eliminator" which appeared in the issues dated December 12th and 19th, 1928.

This eliminator is available for inspection by readers at the Editorial Offices: 116-117, Fleet Street, London, E.C.4.

IS TRANSATLANTIC CABLE TELEPHONY POSSIBLE?

Using the S.G. Valve in an Attenuation-Correcting Amplifier.

RECENT statements in the Press indicate that there is under consideration the project of laying a submarine telephone cable across the Atlantic. Such a system would have obvious advantages in its reliability, secrecy, and immunity from fading and jamming, and, if it were economically sound, and as efficient electrically as commercial landline systems, it would not only be a great scientific achievement but an enterprise of international value.



Frequency characteristic of the screen-grid amplifier arranged to give a resonance below 7,000 cycles.

The technical difficulties involved are considerable, but in view of published information available it would appear that they have been overcome. Some unusual problems are centred around the terminal apparatus. Repeaters or amplifiers for correcting distortion are usually inserted at intervals of 70 to 120 miles in landline practice in order to augment the weakened signals and at the same time to compensate for the loss of upper frequencies. With this requirement in mind it is somewhat bewildering to imagine a distance approaching 2,000 miles to be covered without any intermediate repeating apparatus. Fantastic notions of supporting electrical equipment on buoys or sinking it to the sea bed are quite impracticable. The landline with its repeaters is in many respects analogous to a bridge with a number of piers at intervals, whilst the Atlantic cable is like a mighty suspension bridge supported only at its extremities and requiring colossal piers. In a similar manner the cable requires super-amplifiers.

Enormous Amplification of the Upper Frequencies.

Now many readers have undoubtedly had the experience of listening to broadcasting relayed over poor landlines which have absorbed, owing to their high capacity, the upper frequency currents of the telephonic range. This upper frequency attenuation is much more acute with a long submarine cable, and the problem of reproducing the original signals consists in amplifying the highest frequency of the commercial speech range many thousand times as much as the lowest frequency, the amplification naturally being progressive. This difficult problem has been solved by using the principle of a combination of screen-grid valve and a special transformer having a resonance frequency below 7,000 cycles, the characteristic of the combination being shown in the accompanying diagram. Several units are placed in cascade in the receiving amplifier for the proposed cable, and the output to the landline is controlled by varying the voltage applied to the last stages, which give uniform amplification with frequency.

Data for an actual receiving amplifier show a measured voltage amplification of five million at a frequency of 2,000, which amplification is 40,000 times as great as the value at the lowest frequency considered. An interesting comparison is afforded by the fact that repeaters used on two- and four-wire systems of landlines have voltage amplifications of 30 and 900 respectively at 2,000 cycles.

Input Correction.

The novel amplifying-correcting principle is also employed in the transmitter or outgoing end of the cable. The output from the subscriber's microphone, after reaching the terminal station of the cable, passes into the screen grid valve-transformer stages of the transmitter to boost the upper frequencies beyond their original value, thence to the transmitting valves, and finally to the cable. This "shaped" input to the cable has specific advantages. The total voltage amplification of the receiver and transmitter probably approaches 100 million, which figure has never before been realised in submarine cable engineering.

This interesting information has been extracted from a patent specification granted to Dr. N. W. McLachlan and Mr. W. S. Smith. We look forward with assurance to the day when transatlantic cable telephony is inaugurated.

In Next Week's Issue will appear a description of

The Wireless World

RECORD III.

With A.C. Valves and a balanced screen-grid H.F. Amplifier, the set gives the highest stage magnification yet attained.

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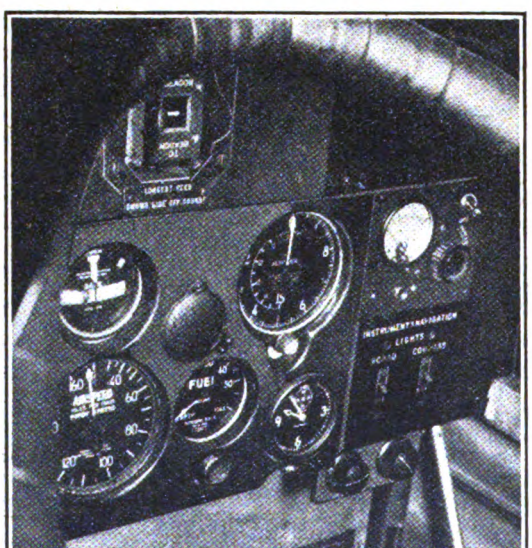
AIR NAVIGATION by WIRELESS

U.S. airplane with vertical aerial.

The Work of the Radio Beacons.

ALTHOUGH services for the transportation of passengers by air are expanding rapidly, they are at present far from attaining that reliability which is so essential in a public service. The greatest obstacle to air passenger traffic arises from the hazards of the weather. Airways and airports are now being provided in abundance in this country and abroad, aircraft of adequate strength are more and more available, every provision is offered for the comfort and convenience of the air traveller, and yet air traffic can still be halted when low visibility prevents the pilot from seeing his landmarks or lights on the ground. Deprived of all landmarks and under intense strain to maintain equilibrium, the aviator is then compelled to abandon dependence on his senses and to navigate according to the information conveyed to him by his instruments. A pilot can continue flying safely in fog by means of devices such as the altimeter, turn indicator and compass, but it is only by the help of radio that he can be certain to keep on a given course and find an invisible aerodrome.

A radio beacon system[1] is in process of erection on the airways of the United States for the purpose of marking out the airway routes so that the pilot can, regardless of fog, keep accurately on his course and receive a definite intimation when he has reached the landing field.



THE RADIO BEACON INDICATOR is the topmost instrument seen in this view of the cockpit. The two white spots mark the extremities of reeds which vibrate vertically when the radio beacon is tuned in.

The radio beacon is a special kind of transmitter located near to the landing ground of an airport. The ordinary simple antenna is replaced by two loop aerials spaced at an angle to each other and rigidly fixed in space. The two loops are excited by a common high-frequency supply, but the individual aerial currents are modulated at a different low frequency. The current in one loop is modulated by an audio-frequency of 65 cycles and the other 85 cycles per second. Each of the aerials emits a directional wireless beam, so that an aeroplane flying along a line equidistant between the two beams will receive two signals of equal intensity, one from each beam. Should the aeroplane deviate from this line, which represents the direct route to the landing ground, it receives a stronger signal from one beam than from the other.

An ingenious indicator on the instrument board of the aeroplane shows when the

[1] J. H. Dellinger, Journal American I.E.E., Feb., 1929.

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Air Navigation by Wireless.—

signals from the two beams are being received with equal intensity. The low-frequency modulation of the incoming waves cause two small reeds to vibrate. One reed, on the pilot's right, is tuned to 65 cycles per second, while the other, on his left, is tuned to 85 cycles per second. The tips of the reeds are painted white against a dark background, so that when vibrating each appears as a vertical white line. If the two white lines are of equal length, i.e., the reeds are vibrating at the same intensity, the pilot is on his correct course. If the one on his right becomes longer than that on his left the aeroplane has drifted off the course to the right, and *vice versa*. Thus, if the pilot deviates from the regular course, either accidentally or to avoid a stormy area, the radio beacon makes this apparent, and shows the way back. The great advantage of the radio beacon system over other kinds of homing devices, such as compasses, is that if the machine is blown off its original course by side winds the destination point can still be located. The radio beacon creates an invisible thread along which the aeroplane travels as unerringly as a train on rails.

The new radio beacon and operating hut at Mitchell Field, N.Y.

Arriving at the Aerodrome.

In foggy weather, however, the pilot's troubles are not ended when he has succeeded in keeping his machine in the invisible "permanent way." Sooner or later he will come to the "buffer stops" at the end of the journey, and his task is then to make a blindfold landing. He must be told, therefore, of the moment when he passes over the radio beacon. The indicator is intended to provide this information. As he flies over the beacon there is a sudden relaxing of the reeds, due to a region of zero signal strength immediately above the transmission tower, and he is able to locate the landing ground to within 100 feet. This arrangement works well in theory, but in practice it cannot be said that the problem of landing in fog has been completely solved.

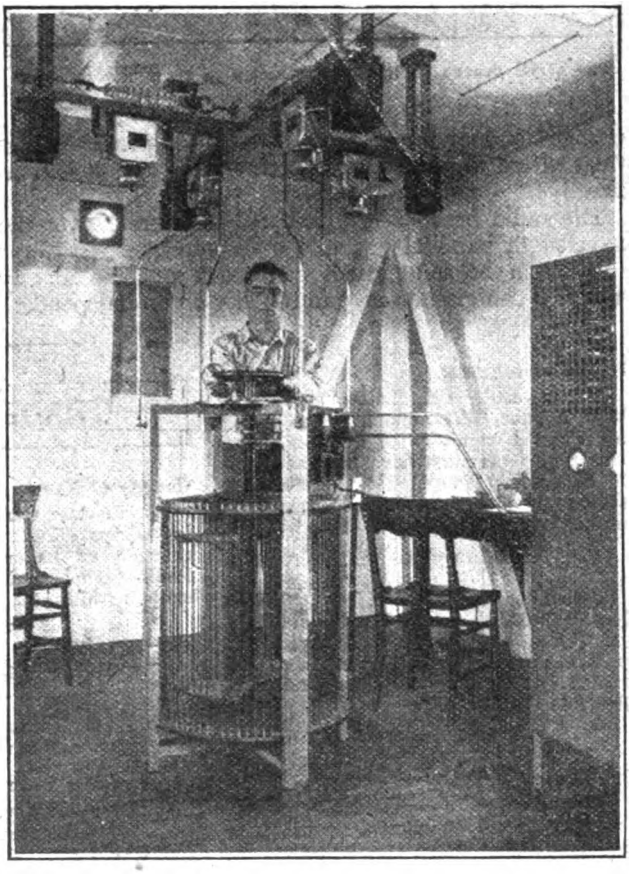
A costly but more reliable method of guiding aeroplanes to their landing ground in fog is employed in this country and France and is known as the "leader cable" system. A straight side of a buried loop of cable, oval in shape and measuring possibly as much as 6 × 2 miles, runs through the aerodrome. Adjacent to this straight side and encircling the portion of the aerodrome which is free for landing purposes is a second and smaller buried loop. The pilot gradually descends in circles, following the track of the larger loop by means of his induction operated equipment. With each revolution he picks up a signal from the smaller loop, indicating that he is above his landing place. When sufficiently low he is then able to plunge through the fog and make a safe landing.

The Capacity Altimeter.

This method presupposes the installation on the aeroplane of a reliable altimeter. In this department, too, radio principles are applied with considerable success. The capacity altimeter determines the distance from the ground by means of two condenser plates on the 'plane. As the ground is approached the electrical capacity change affords an indication of height, though, unfortunately, the changes in capacity are too minute to be observed at heights above 100 feet. Dr. E. F. W. Alexanderson, the well-known American research worker, has recently experimented with an altimeter in which use is made of the direct reflection of radio waves between aeroplane and ground.

The whole receiving system as used on the U.S. airways comprises a 10-foot vertical rod aerial, a small indicator unit on the instrument board weighing one pound, a receiving set weighing less than 10lb., which may also be used to pick up radio telephone signals, and a 10lb. battery.

Besides being sensitive, the receiver is highly selective,



Setting the "goniometer" at the Mitchell Field beacon. The lead-in conductors are connected to aerials at the four points of the compass.

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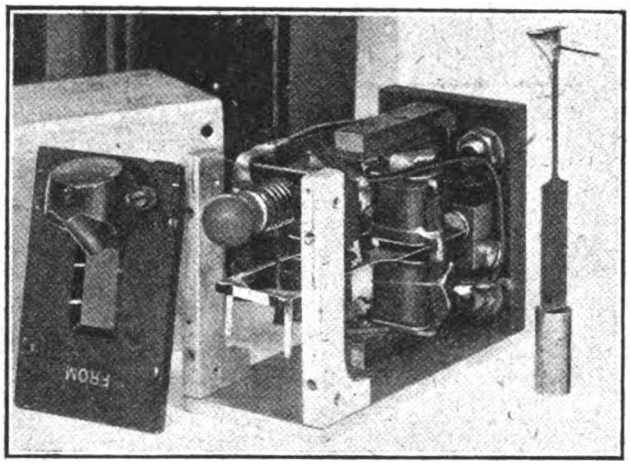
Air Navigation by Wireless.—

with interstage shielding as well as shielding against interference from the magneto. The vibrating reeds assist, of course, in securing selectivity. Remote control tuning is employed, so that the set may be placed in any part of the machine.

The abandonment of the trailing wire aerial has come as a welcome relief to airmen. Not only was it a source of anxiety due to the risk of entanglement with objects on the ground, but it played strange directional tricks



The aerial beacon indicator dismantled to show the principle of operation.

at night and at times when high winds prevailed. A great virtue of the vertical pole aerial is that it is non-directive.

The radio beacons are designed to operate over the wavelength band of 925 to 1,050 metres.

While a beacon system can mark out the airway routes, it can give no help to the flier on an independent course. Two methods of adapting radio to this navigational need are in use.

In the first, radio direction finding stations are maintained at various air ports, and each aeroplane carries both a transmitting and receiving set. Upon request by the pilot, two or more of the direction finding stations determine the direction of travel of wireless waves from the 'plane. Combining their determinations, they calculate the aeroplane's position and send this information by radio to the pilot.

The second method of helping the independent flier is the rotating radio beacon. This is a radio transmitting station, located at an air port, which has a rotating directive aerial, causing a beam of wireless waves to sweep constantly around. A special signal indicates when the beam passes through north. A pilot listening for this beacon's signal with his receiving set can determine his direction by the time which elapses between the north signal and the instant when the beam is heard with maximum intensity. The elapsed time is determined by means of a stop-watch, which can be calibrated to read direction.

A stop-watch used for direct reading from the experimental rotating wireless beacon at Orfordness, Suffolk. The watch is started from zero when the beacon gives the "north" signal and is stopped when signals are loudest, the beacon rotating at the same speed as the watch hand.

Commercial reliability of air travel would seem to depend entirely on the use of radio. Certainly any practical scheme for a transoceanic air service would require directional radio aid, particularly for a system such as that involving a number of seadromes anchored across the ocean.

Change of Address.

Pertrix, Ltd., 120, Tottenham Court Road, London, W.1, announce that, owing to continued expansion of business, more commodious premises have been acquired at Britannia House, 233, Shaftesbury Avenue, London, W.C.2. The telephone number is Temple Bar 7971 (four lines).

oooo

Cliftophone and Records, Ltd., "Radio Dept.," 95, Park Street, Southwark, London, S.E.1, have acquired new premises at Woodstock Road, Shepherd's Bush, London, W.12. The telephone number is Riverside 4611.

oooo

New Branch Office.

Messrs Ward and Goldstone, Ltd., Frederick Road, Pendleton, Manchester, have opened a branch establishment at Upton's Yard, 49a, Briggate, Leeds. The telephone number is Leeds 26812, and the telegraphic address Multum, Leeds.

TRADE NOTES.

Change of Name.

The Electron Company, Ltd., 122, Charing Cross Road, London, W.C.2, has changed its name to: The Six-Sixty Radio Company, Ltd. The address remains as hitherto.

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Catalogues Received.

Messrs. Wright and Weaire, Ltd., 740, High Road, Tottenham, London, N.17.—Illustrated catalogue of "Wearite" components

oooo

Messrs Whiteley, Boneham and Co., Ltd., Nottingham Road, Mansfield, Notts.—Illustrated folder dealing with the Lodestone Moving Coil loud speaker; also cabinet cone speakers and valve holders.

Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware, Middlesex.—Descriptive folder of the Watmel balanced armature loud speaker unit; also constructor's blue-print of the 1929 "Imperial Three" receiver.

oooo

Messrs. Claude Lyons, Ltd., 76, Old Hall Street, Liverpool.—Descriptive folder of the "B.A.T." L.T. battery eliminator for A.C. mains; also illustrated leaflet describing the "B.A.T." push-pull output "Gramo-Radio" two-stage amplifier.

oooo

Columbia Gramophone Co., Ltd., 102-108, Clerkenwell Road, London, E.C.1.—The Columbia Review and current monthly list of new gramophone records.

oooo

Mullard Wireless Service Co., Ltd., Mullard House, Charing Cross Road, London, W.C.2.—Illustrated leaflet of Mullard "Pure Music Speaker" type "H."

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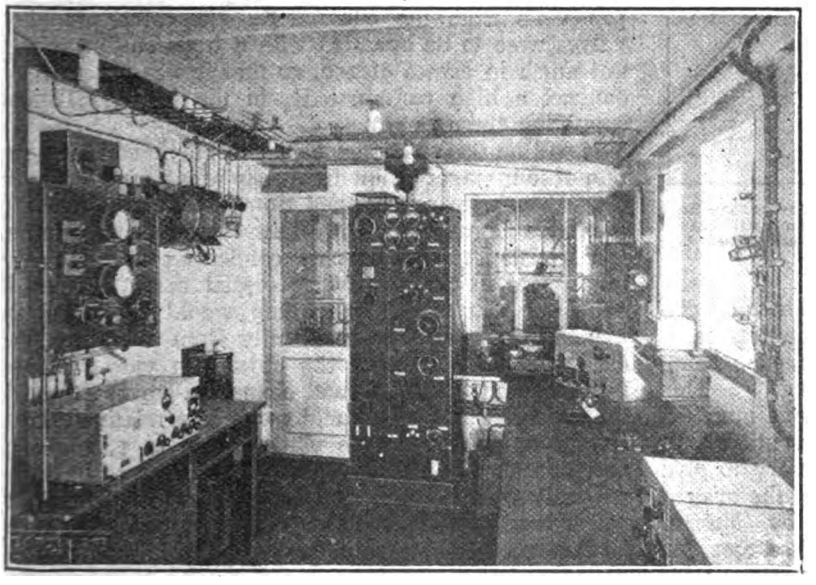
RADIO on the "BREMEN"

High-speed Telegraphy, Telephony and Short-wave Equipments.

THE new Norddeutche Lloyd liner *Bremen*, which has recently established a new transatlantic speed record, is equipped with the most modern type of radio apparatus. Its transmitters and receivers embody many new and interesting recent developments of the Telefunken Company.

The transmitter, which is of the oscillator-driven type, is readily adapted to give continuous wave, interrupted continuous wave and telephony. Wavelengths of from 500 to 3,000 metres are provided, and the aerial energy is 3 kW. The circuit arrangement permits of exact calibration of the master oscillator, and wavelength changes are effected in less than thirty seconds. Direct current at 4,000 volts is taken from a rotary machine. In addition to the main transmitting equipment are three other transmitters. One of these is a short-wave long-distance set using 700 watts. This again includes a calibrated drive oscillator and intermediate circuit. Provision is made for telephony transmission with this short-wave set, and in order to conform to the requirements of the Washington Convention, long-distance telephony transmissions will be transferred from the main transmitter to this equipment after January 1st next. A medium-wave transmitter is also installed for handling traffic at short range, and consists of a modulated C.W. set with a wave range of 580 to 830 metres and an aerial power of about 200 watts. In addition there is the emergency equipment, which is an accumulator-driven spark set and arranged to be independent of the ship's power supply.

Various receiving sets are installed for independently working on the several wave ranges, while a complete receiver with loud speaker output is kept permanently tuned to 600 metres for the reception of distress signals. Automatic high-speed keying facilitates the handling of a large amount of traffic, which is disposed of through the German station at Norddeich and the American station at Marion. A keying speed of 250 words a minute is maintained. A staff of six operators is required to conduct the wireless service, while the radio direction-finding gear which is also installed is handled by the navigating staff. Two of the motor-driven lifeboats are equipped for transmission and reception. Power is derived from a 24-volt accumulator of 100 ampere-hour capacity and applied to an alternating current generator. Reception by both valve and crystal is provided. Collapsible masts support a small two-wire aerial. Similar radio equipment to that of the *Bremen* is being installed aboard the *Europa*, now under construction.



The *Bremen's* radio cabin. The main transmitter control is in the centre while several of the receiving sets can be seen.

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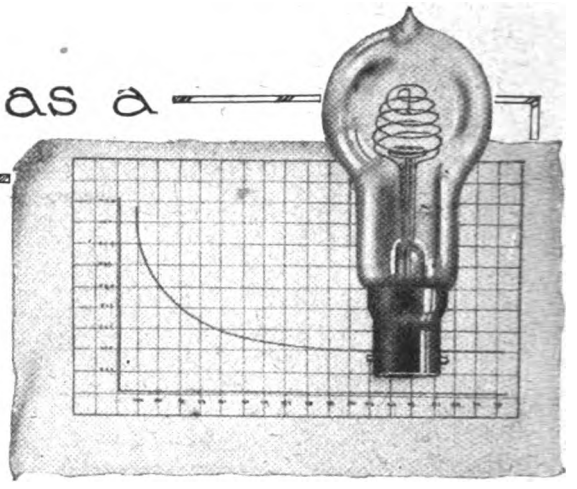
The NEON LAMP as a STABILISER



How Feed-back can be Avoided in Eliminators.

By S. O. PEARSON, B.Sc., A.M.I.E.E

THERE are many wireless receiving sets in existence in which the output valve or valves are of the high voltage type, requiring anything from 300 to 500 volts on the plates, whereas the preceding valves are of the more usual type which operate with plate voltages of 150 or less. In a great many instances an extra stage employing the push-pull system with valves of the L.S.5A class has been added to an existing set for the purpose of driving a moving-coil type loud speaker.

With such a set the use of a high-tension battery eliminator is almost essential on account of the prohibitive cost of batteries with sufficiently high voltage and ampere-hour capacity. Now, it is already well known that very special precautions have to be taken when a battery eliminator is used, to prevent feed-back

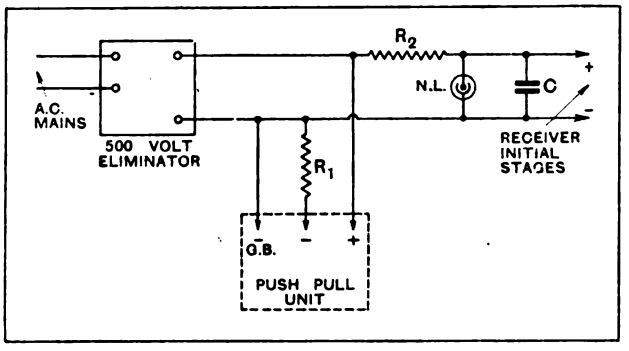


Fig. 1.—Schematic diagram showing how a neon lamp may be used for stabilising in a composite set where two widely differing values of H.T. voltage are required. N.L. is the neon lamp. C should have a value of 2 to 4 mfd.

effects due to its high internal resistance. These effects, if not counteracted, usually result in continuous oscillation at a very low frequency, the phenomenon being commonly referred to as "motor boating." This subject has been fully dealt with in previous numbers of *The Wireless World*, and methods of prevention have been explained, so that it will not be necessary to give more than a brief reference here. So far, the system of anode-feed filter circuits developed by Messrs. Ferranti has proved the most successful scheme for the prevention of 'motor boating"; the plate circuits of all but the last stage are fed through series resistances with large by-pass condensers to prevent the current variations from passing through the eliminator and its filter circuits. Unless the push-pull arrangement is employed the loud speaker is connected to the last valve through the usual choke-capacity filter system.

Some time ago the writer had occasion to use a note magnifier with three stages of amplification before the push-pull output stage. The actual valves used, taken in order, were D.E.5B, D.E.5, D.E.5A, and two L.S.5A valves in push-pull, the first and second and the second and third stages being resistance-coupled. The push-pull portion was built as a separate portable unit. An eliminator was constructed to give 500 volts with an output of about 70 milliamps., the usual smoothing circuit being included. Both H.T. supply and grid bias for the L.S.5A valves were obtained from the eliminator by including a resistance in the negative H.T. lead as shown at R_1 in the schematic diagram of Fig. 1. Under working conditions the voltage on the plates was 375, with a negative grid bias of 125, making a total of 500 volts from the eliminator. The three preceding valves were to be operated with a high-tension voltage not much in excess of 150, so that it was necessary to connect a high resistance R_2 in the main H.T. lead supplying these stages.

It will be realised at once that to obtain stable operation of four stages of low-frequency amplification, where the valves were all supplied from the same eliminator, presented no easy problem. The system of separate series feed resistances and by-pass condensers proved to be inadequate in this somewhat special case. At first it appeared that the only solution would be to supply the first two stages independently from a battery, but such a scheme defeated the objects in view. It was fully realised that any small change in current through the high resistance R_2 would result in a relatively large change of voltage on the plates of valves 1, 2 and 3, and that should the filaments of these valves be inadvertently switched off before the H.T. supply the full 500 volts would build up across the various by-pass condensers in this part of the amplifier, with disastrous results, since it was designed for a working voltage of 150 only. It was obviously necessary to connect some sort of

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The Neon Lamp as a Stabiliser.—

permanent load in parallel to eliminate this danger and to reduce the voltage variations due to the changes in the useful load current.

It was here that the use of a neon lamp suggested itself on account of its special properties: A neon lamp does not behave like an ordinary resistance; *a given change in the voltage applied to the lamp results in a very large change of current compared with the current change which occurs in an ordinary resistance for the same variation of voltage,* the initial current being the same in each case.

And so a neon lamp with the safety resistance removed from the cap was connected in parallel with the low-voltage part of the amplifier. The result was highly successful from the outset, and led to further experiments which proved that the inclusion of a neon lamp in this manner was of great advantage in any receiver where the eliminator voltage exceeded 150 when on load. The writer has found that oscillation and "motor boating" cease entirely *even when the anode feed resistances are omitted.* With the four-stage note magnifier referred to above no resistances were required other than the series resistance R_2 necessary to drop the voltage down to the requisite level. Fig. 1 gives a schematic diagram of the arrangement used.

D.C. Characteristics of Neon Lamp.

It will be helpful first to discuss the chief characteristics of a neon lamp in order that as simple an explanation as possible may be given as to why its inclusion has such a beneficial effect. Later actual

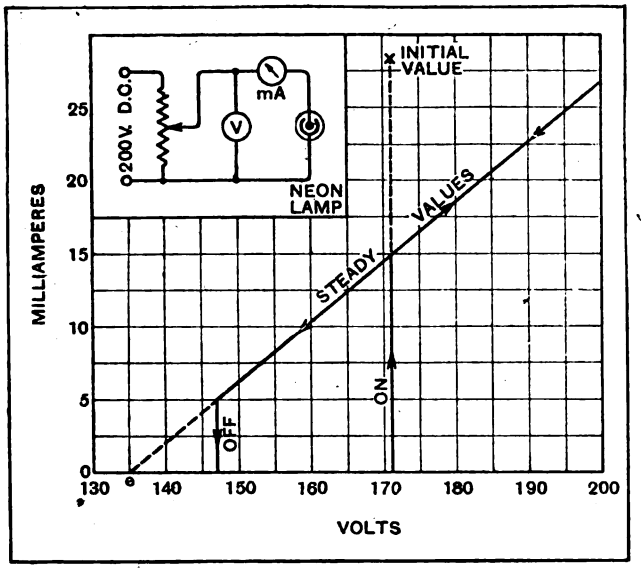

Fig. 2.—Static characteristic curve of neon lamp. The circuit arrangement for obtaining the curve is shown.

figures are given showing how pronounced the stabilising effect really is and at the same time indicating how the circuit is designed to suit any particular set of conditions.

The neon lamp in its commercial form has a steadying or ballasting resistance connected in series and mounted inside the cap in order to prevent the possibility of an arc forming between the electrodes when the lamp is switched on to the mains. For our purpose it is necessary that this resistance should be removed, or that a lamp without any ballasting resistance be purchased from the manufacturers.

When the requisite voltage is applied to the electrodes of a neon lamp the glow is formed over the entire

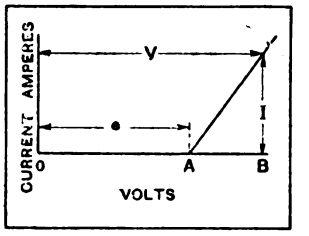

Fig. 3.—Diagram enabling the relationship between voltage and current for the neon lamp to be obtained in the form of an equation similar to that for a battery on charge.

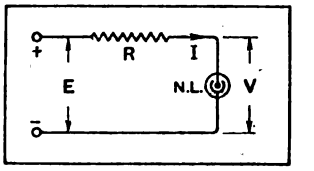

Fig. 4.—When a resistance R is connected in series with the neon lamp, the voltage V across the lamp varies only slightly when R is varied over a wide range.

surface of the cathode, or negative electrode, while the anode does not glow at all unless the voltage is excessive. It is important to note that the initial current taken by the lamp when switched on cold is very much greater than the final steady value to which the current falls after the gas in the bulb has had time to warm up. The current attains a steady value after about four or five minutes, and this may be less than half the initial value.

If the voltage applied to the lamp is gradually increased from zero it is found that no current whatever flows and no glow occurs until the voltage reaches a definite critical value, at which the current suddenly jumps up from zero to something like 30 milliamps., and then gradually drops to about half this value as the lamp heats up, the applied voltage being maintained constant at the critical value at which the current commenced.

Critical Starting Voltage of Neon Lamp.

For a particular lamp tested the glow was established when the applied E.M.F. reached 171 volts, and after about five minutes the current, with this voltage maintained, settled down to a steady value of 14.7 milliamps. The voltage was then increased in steps and the corresponding values of the current noted, the results of these observations being shown by the graph of Fig. 2. It will be seen that the graph is a straight line—a point of considerable importance, as will be seen later. On reducing the voltage again in stages it was found that the current did not cease to flow when the critical starting voltage of 171 was reached and passed, but continued to fall according to the same straight-line law until, at 147 volts, it suddenly ceased and the lamp went out. Fig. 2 gives the complete cycle of current changes for variation of voltage from zero up to 200 and back again to zero. As the lamp should not be run at voltages above about 200 without the safety resistance in the cap we see that, once the glow is established, we have a useful voltage range from about 150 to 200. If the graph is projected

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The Neon Lamp as a Stabiliser.—

downwards to meet the voltage-axis, as shown by the dotted line, the intersection occurs at about 135 volts, a figure which we shall have to make use of in the calculations to follow.

The fact that the current varies according to a straight-line law renders the theory and calculations relating to our particular problem so delightfully simple that we only need to use Ohm's law. The first thing we require to know is the equation showing the relation between voltage and current. If the current in amps. is plotted against voltage, as in Fig. 3, and the graph produced downwards to meet the voltage axis at A, we see at once that the current is exactly proportional to the amount by which the voltage exceeds the value OA. Let OA = e volts, and let I be the current when the voltage applied to the lamp is OB = V, where V is greater than e.

Neon Lamp Equivalent to Floating Battery.

Then I is proportional to AB, and AB = V − e; that is to say, the current is proportional to the difference between the applied voltage V and a constant back E.M.F. of value e, or, in other words, $\frac{V-e}{I}$ is a constant. These are exactly the same conditions which obtain when a battery is being charged, the charging current being equal to the difference between the applied E.M.F. and the back E.M.F. divided by the resistance. Thus we can liken the neon lamp to a battery on charge and apply the usual methods of

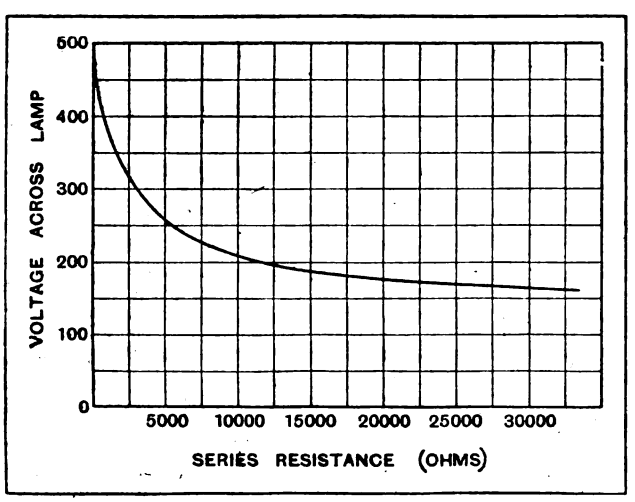

Fig. 5.—Curve showing how the voltage across the neon lamp varies as the series resistance is increased. The supply voltage was assumed constant at 500 volts.

calculation. For instance, $(V-e)/I = r$, where r is the internal resistance of the equivalent battery, e is its E.M.F., and V the applied charging voltage.

Referring to Fig 2 again, we see that for the lamp under test, $e = 135$, and that when V = 160 volts, I = 10 milliamps. or 0.01 amp.

Therefore $r = \frac{160-135}{0.01} = 2{,}500$ ohms, and the equation showing the relation between voltage and current for this lamp becomes

$$I = \frac{V-135}{2{,}500} \text{ amps.} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

for voltages greater than 147.

Clearly then the use of the neon lamp in parallel with a variable load is equivalent to the use of a floating battery whose internal resistance is 2,500 ohms and whose E.M.F. is 135 volts, and it will have the same smoothing effect as such a battery. At first sight this resistance might appear to be too high to allow of efficient stabilising, but, of course, this depends on the relative resistance of the useful load in parallel with the lamp. For an average case of, say, 10 milliamps. at 150 volts, the load resistance is 15,000 ohms—several times greater than the equivalent battery resistance of the neon lamp. It must be remembered that the lamp itself only takes a small current in spite of its low equivalent resistance, on account of the back E.M.F. A plain resistance of 2,500 ohms in parallel with the load would certainly have the same smoothing effect, but would take such a large current that the eliminator would be overloaded and the voltage pulled down to a very low figure.

The Value of the Series Resistance.

First consider a circuit consisting of a variable resistance R in series with the neon lamp, as shown in Fig. 4. Let E be the value of a constant voltage sufficiently great to light the lamp applied to the ends of the circuit, and let V be the resulting voltage across the lamp itself. Then the voltage across R will be (E − V), and by Ohm's law the current is

$$I = \frac{E-V}{R} \text{ amps}$$

or

$$\frac{E-V}{I} \text{ ohms.}$$

But by equation (1) $I = \frac{V-135}{2{,}500}$ amps.

and, therefore, $R = 2{,}500\,\frac{E-V}{V-135}$ ohms $\ldots\ldots\ldots\ldots (2)$

This enables us to determine the series resistance necessary to give any desired voltage across the lamp with a given supply voltage E. For instance, with an eliminator giving 500 volts, if we desired 190 volts across the lamp, with the valves representing the useful load switched off, the necessary series resistance would be

$$R = 2{,}500\,\frac{500-190}{190-135} = 14{,}100 \text{ ohms.}$$

A number of values have been worked out in this manner for a 500-volt supply, and the voltage V obtained for various values of R is given by the curve of Fig. 5. The outstanding feature shown by the curve is that the voltage across the lamp varies only slightly for relatively large changes of resistance above 10,000 ohms. For instance, raising the series resistance from 15,000 to 30,000 ohms lowers the voltage across the lamp from 186 to 163, a matter of only just over 12 per cent. This indicates that the series resistance need not be critically adjusted to the value calculated.

(To be concluded.)

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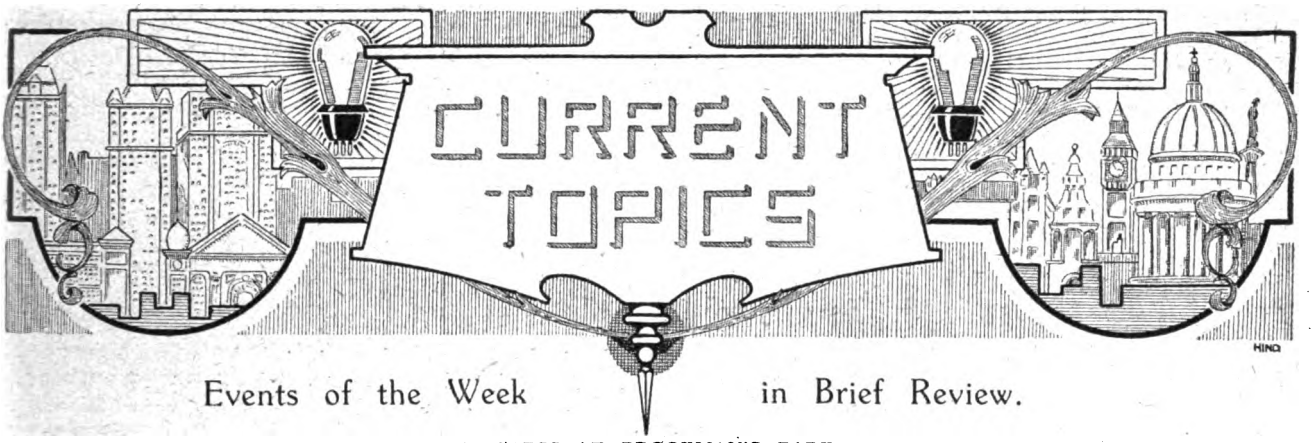

MAZDA VALVES.

As the result of an arrangement between the Edison Swan Electric Co., Ltd., the British Thomson-Houston Co., Ltd., and Metro-Vick Supplies, Ltd., the well-known valves of these three companies (Ediswan, Mazda and Cosmos) will in future be marketed entirely by the Edison-Swan Company, who have taken over the selling organisation as from August 12th, and they will all be known as the "Mazda" valves.

At the same time we understand that the three individual companies can still supply some of their last year's types if these valves are specifically required for replacements in existing sets.

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WIRELESS SHOW IN ROUMANIA.

The first International Exhibition of Radio and Electrical Household Apparatus will be held in Bucharest from September 1st to 20th, at which it is expected that manufacturers from all countries in Europe will be represented.

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THE CURSE OF BABEL.

It is stated that the one official language to be used at the World Radio Conference to be held at The Hague will be French. This, we understand, has aroused protests, especially from America, as it is not easy to find men who combine the understanding of wireless technicalities with a fluent command of the French language. It has been suggested that use might be made of the Filene-Finlay system of translation, as at the Geneva Conferences, where delegates are provided with head telephones, connected with sundry microphones into which experts translate the speeches, sentence by sentence as they are delivered, into the required languages. The difficulty, however, would still remain of finding ready translators with the necessary technical knowledge of the intricate problems of wireless transmission and reception.

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BY LAND LINE TO AMERICA.

A rival to transatlantic wireless telephony is projected by the American Telegraph and Telephone Company, who have decided to lay a telephone cable between Frenchport, Co. Mayo, and Newfoundland, which will eventually link up London and New York by wired telephony.

PROGRESS AT BROOKMAN'S PARK.

Testing in the new regional station is in energetic progress. Unmodulated carrier waves have for some time been transmitted from its aerials, and by the time these notes are published it is probable that modulated tests will be broadcast outside the regular programme hours.

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RESERVE YOUR JUDGMENT.

Listeners who may chance to hear these preliminary tests should not, however, judge the station by them, as the power is often considerably varied, and it is unlikely that the transmitters will be called on to work to their full capacity with an output of 50 kW. to the aerial, even when employed for the regular broadcast service.

Engineers are very conservative, and like to have a little extra in reserve. It may also be found expedient to use rather more power for the shorter wavelength, as the aim of the B.B.C. is to get equal strength for both programmes at the normal outward limit of the area to be served, and the 261 metre wavelength may show signs of attenuation more rapidly than that of 356 metres.

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BELGIAN WIRELESS SALON.

The annual Brussels Radio Salon will be held this year in the Palais du Cinquantaire from October 12th to 21st.

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SHORT-WAVE SETS ON SHIPS.

Owing to the extreme ranges obtainable at comparatively low powers with short-wave sets, they are being installed on an increasing number of ships. The Marconi Company has recently produced a short-wave combined telegraph and telephone transmitter known as Type T.N.7, with which communication has been established over distances of more than 6,000 miles.

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BROADCAST COPYRIGHT IN FRANCE.

The Litigation Committee of the French Education Department has decided that university professors have a legal right to authors' royalties when their lectures are broadcast.

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ANOTHER AUTUMN SALON.

Bordeaux will hold its wireless salon this year from October 25th to November 3rd.

STOLEN GOODS.

Messrs. Whittingham, Smith and Co., of Park Royal, N.W.10, ask us to state that on the night of August 15th four "Portadyne" Junior Receivers in hide cases were stolen from their works and that they would be glad to hear from any dealers or others to whom they may be offered. The serial numbers are 2178, 2181, 2185 and 2091.

We understand that the theft of portable sets is becoming a somewhat common practice, and that they are often offered on an alleged hire-purchase system to an unsuspecting buyer, who is asked to pay a deposit which, he is told, entitles him to retain the receiver for three months, after which time the first of ten monthly instalments for the balance will be collected. Needless to say, the seller never calls again for this, and the purchaser is left with a stolen receiver on his hands.

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DUBLIN WIRELESS SHOW.

The Radio Exhibition for the Irish Free State will be held at the Mansion House, Dublin, from October 26th to November 1st.

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SPANISH WIRELESS LICENCES.

The Spanish authorities have fixed the licences payable on receiving and transmitting sets at the following rates: Crystal receivers one peseta (8d.) quarterly; valve sets, 5 pesetas (3s. 4d.) quarterly; and transmitting apparatus, 5 per cent., *ad valorem*. The proceeds from these taxes will be devoted to maintaining the broadcasting services.

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DIFFICULTIES IN NORTHERN IRELAND.

Listeners in the area served by the Belfast station are not entirely enthusiastic over the change of wavelength, under the Prague Plan, from 306 metres to 242 metres. Wireless dealers are by no means plentiful in many of the outlying districts, and users of crystal sets sometimes experience difficulty in getting suitable coils to adapt their receivers to the new wavelength.

The B.B.C. will probably give demonstrations in Northern Ireland to prove that it is really easy to get Belfast with a suitably designed crystal set and generally to help those listeners who are experiencing difficulties.

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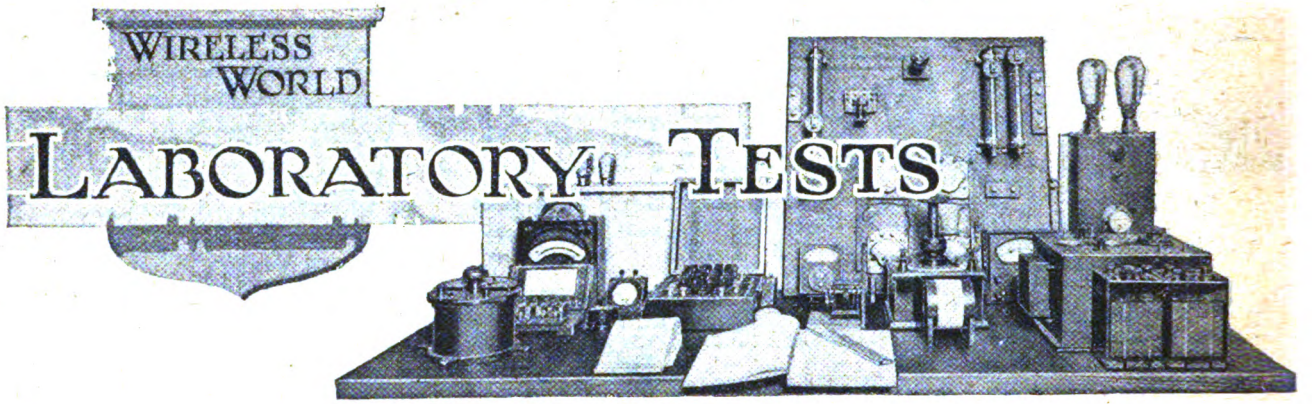
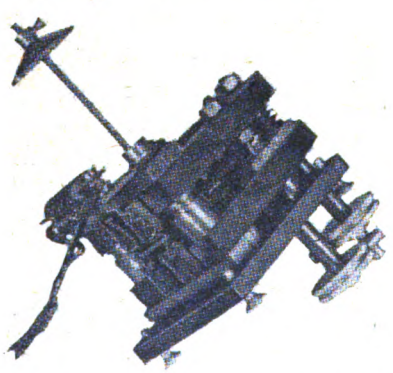


A Review of Manufacturers' Recent Products.

WATES "STAR" LOUD SPEAKER UNIT.

This cone loud speaker unit is of the double-acting reed type and embodies two permanent magnets, four laminated pole-pieces and four coils. The vibrating reed, which is disposed centrally between the four poles, is fixed at one end and is provided with an adjusting screw for regulating the position of the reed in the gap.

A feature of unusual interest is the provision of an extra adjusting screw which enables the upper magnet system to be moved away from, or closer to, the lower magnet. This, in effect, alters the width of the air gap in which the armature vibrates. This double adjustment confers the decided advantage of a small gap when maximum sensitivity is required, and at the same time assuring that the reed will be centrally disposed in the gap. Likewise, when large inputs are available the gap can be opened and the position of the reed altered to meet the new conditions.



Wates "Duplex" cone loud speaker unit with double adjustment.

A practical test was made with the unit attached to a "floating" cone mounted on a three-feet square baffle board. Sensitivity is good and although the unit will deliver ample volume to fill a room of more than average size it will not accept a large input without signs of distress. A small power valve will operate this unit at sufficient volume to meet most requirements.

The response, as judged by the ear, is reasonably good over the major portion of the audible scale, but there is a tendency to over-emphasise slightly the middle register.

The sample tested was the "Duplex Model," which is offered at 36s. A cheaper type known as the "Popular Model" is available also, the price being 22s. 6d. These units are obtainable from the Shaftesbury Radio Co., 184-188, Shaftesbury Avenue, London, W.C.2.

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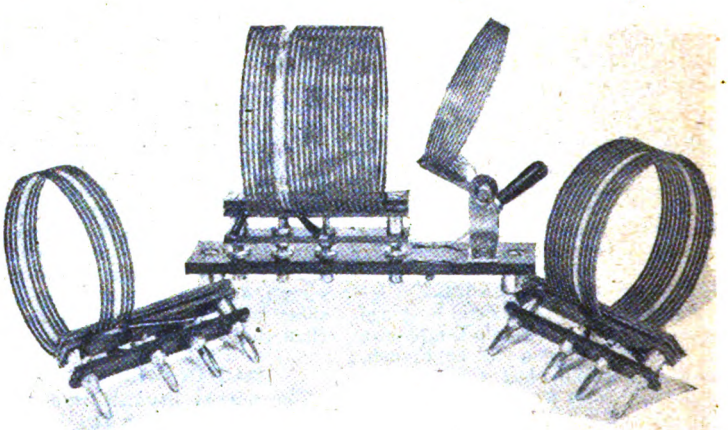
HAMMARLUND SHORT-WAVE COIL UNIT. Type S.W.T.3.

Some recent modifications have been made to the Hammarlund short-wave coil units which should make for improved efficiency. The coils are constructed as hitherto, the turns being wound and firmly attached to a specially prepared former made from material resembling celluloid.

The main point of interest, however, is in connection with the plugs on the interchangeable grid and reaction coil units. The shanks of these are square in section but of the "banana" type. Contact is made between the edges of the plugs and the inside of the sockets and, since these are relatively sharp, they tend to cut into the metal, thereby making a "clean" contact. On very short waves a "dirty" contact can be extremely troublesome and, moreover, will give rise to objectionable noises often quite sufficient to drown weak signals. Likewise, contact with the aerial coil is, for the same reason, made *via* the medium of two phosphor-bronze semicircular springs. The set illustrated is the type S.W.T.3 and consists of three interchangeable units which cover all wavelengths between 15 and 107 metres when the grid coils are tuned by a 0.00014 mfd. variable condenser.



Hammarlund short-wave coil unit, type S.W.T.3.

Hammarlund apparatus is obtainable from the Rothermel Corporation, Ltd., 24 and 26, Maddox Street, London, W.1. The price of the short-wave coil unit is 48s. 6d

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Lack of space necessitates the holding over of the publication of the test report of the B.T.H. gramophone pick-up, to which reference was made in last week's issue.

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VALVES WE HAVE TESTED

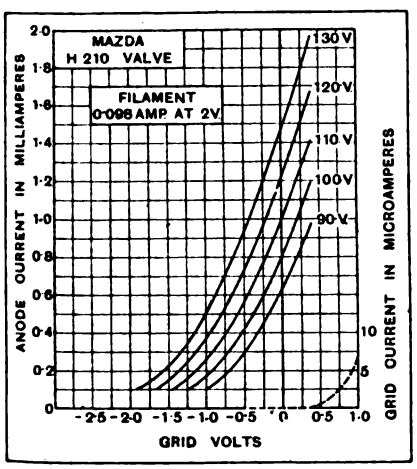
THE NEW MAZDA VALVES.

A Range of Two-volt Valves with Good Mutual Conductances.

WITHIN a few days a new range of "Mazda" valves will be placed on the market. The selling organisation for these will be the Edison, Swan Electric Co., Ltd., Mazda House, 1, Newman Street, London, W.1. The specimens dealt with in this review comprise those designed for use with a two-volt accumulator, the range consisting of seven valves in all; five triodes, a screen-grid H.F. valve, and a pentode.

Type H 210.

This is fitted with a 0.1 amp. filament, and has been designed for use as an amplifier or detector, but, since its rated characteristics are A.C. resistance 59,000 ohms, amplification factor 47 and mutual conductance 0.8 mA. per volt, its most useful function would appear to be that of an anode bend detector followed by a resistance-capacity intervalve coupling. However, it can be used advantageously as an L.F. amplifier, using either R.C. or choke-capacity coupling.



Average values under working conditions; A.C. resistance, 50,000 ohms; amplification factor, 45; mutual inductance, 0.9 mA/volt.

A specimen was tested, and the measured characteristics were found to agree sensibly with the maker's figures. At 100 volts H.T. and zero grid bias, the A.C. resistance was found to be 51,300 ohms, the amplification factor 44.5, and the mutual conductance 0.87 mA. per volt. Since it will be used normally as an amplifier, without grid bias other than that obtained by returning the grid to the L.T. −, the values under

New Mazda two-volt valves. On the left is the SG215, a triode occupies the centre position, and the 230 Pen is on the right.

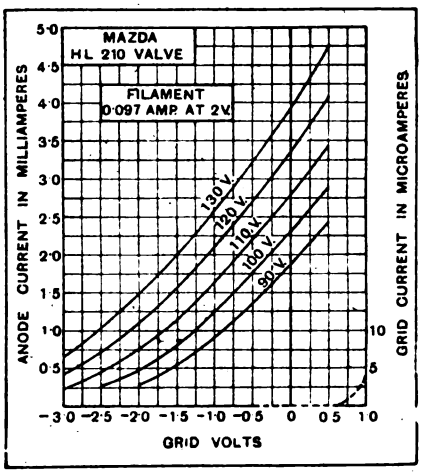
normal working conditions will not show any appreciable change. This condition is made possible by the fact that grid current does not start to flow until the grid acquires a positive potential of approximately plus 0.4 of a volt. When used with the maximum anode potential—namely, 150 volts—a small negative bias of between 0.5 and 1.0 volt would be advisable with the aid of a potentiometer if full advantage is to be taken of the maximum permissible grid swing without causing grid current to flow.

Type HL 210.

In a modern set the two positions most likely to enable the best to be obtained from this valve is the detector stage or first L.F. position, provided two low-frequency amplifiers are used. It will efficiently perform the service of an H.F. amplifier where a neutralised stage is employed. No alteration will be necessary to the H.F. transformer, since the rated characteristics of the valve are: A.C. resistance 21,000 ohms, amplification factor 26, and mutual conductance 1.25 mA. per volt.

Measurements obtained from a specimen of this type gave the characteristics at 100 volts H.T., and zero grid as being: A.C. resistance 20,500 ohms, amplification factor 25.8, and mutual conductance 1.26 mA. per volt. Grid current starts at plus 0.5 volt grid bias, so that with anode voltages greater than 110 a negative bias of 1.5 volts will be required when using the valve for amplifying purposes.

In the detector position it will serve equally satisfactorily as an anode bend or a leaky grid rectifier. Resistance-capacity coupling would be the best medium for linking the anode bend arrangement to the following valve, although a transformer with a large primary would be admissible if the output stage follows immediately after the detector. With grid rectification the use of a transformer is certainly permissible.



Average values under working conditions; A.C. resistance, 21,650 ohms; amplification factor, 23.6; mutual conductance, 1.09 mA/volt.

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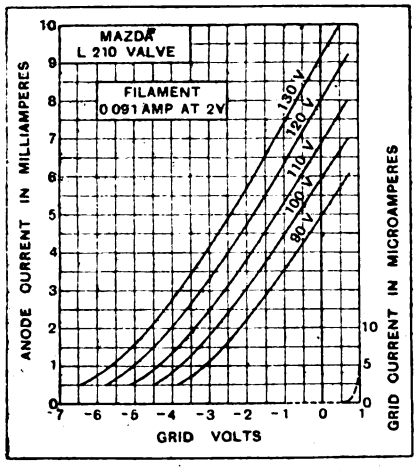
Valves we have Tested.—

Type L 210.

This may well be regarded as the general-purpose valve in the series, for the reason that, with nominal characteristics of A.C. resistance 10,000 ohms, amplification factor 15.5, and mutual conductance 1.55 mA. per volt, many diverse applications can be found for it. In particular, it will probably find greatest application as a penultimate valve in an amplifier of two or more stages used either for radio or gramophone reproduction, especially the latter.

The measured characteristics taken at 100 volts H.T. and zero grid bias were: A.C. resistance 10,130 ohms, amplification factor 15.7, and mutual conductance 1.55 mA. per volt. A use which should be given more than a passing thought is that of an anode



Average values under working conditions; A.C. resistance, 11,100 ohms; amplification factor, 16; mutual conductance, 1.44 mA/volt.

bend detector followed by transformer coupling to an output stage.

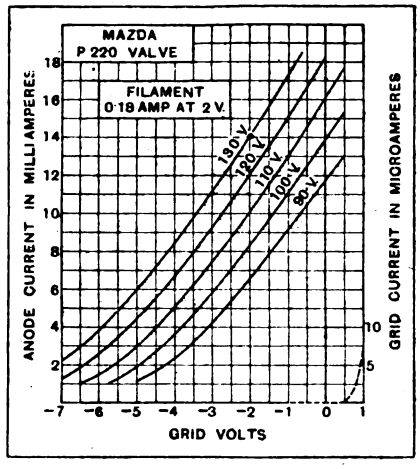
When employed as an amplifier with 120 volts H.T., a negative grid bias of 3 volts will be necessary. At 150 volts H.T. a grid bias of −4.5 volts will be satisfactory.

Type P 220.

The P 220 is a small power valve requiring 0.2 amp. of current at 2 volts for the filament. It will deliver sufficient undistorted power to operate sensitive loud speakers of the horn or cone variety at ample volume for small rooms or where a large output is not required.

CHARACTERISTICS MEASURED AT 100 VOLTS H.T. AND ZERO GRI BIAS.

P 220.	A.C. Resistance Ohms	Amplification Factor.	Mutual Conductance.
Maker's Rating.	3,700	12.5	3.4 mA/Volt
Measured Values	4,350	13.5	3.1 mA/Volt

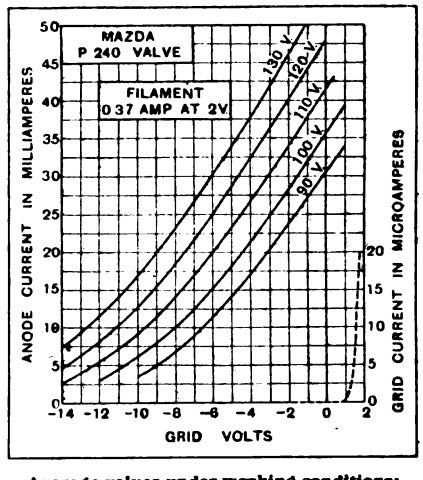


Average values under working conditions; A.C. resistance, 5,600 ohms; amplification factor, 14; mutual conductance, 2.5 mA/volt.

Type P 240.

This is the super-power output valve of the 2-volt class, and accordingly will find itself occupying the last position in an amplifier designed for fairly large power work, such as operating moving-coil loud speakers, or a number of small cone-type instruments. Its rated characteristics are: A.C. resistance 1,900 ohms, amplification factor 7.0, and mutual conductance 3.7 mA. per volt.

The sample specimen measured at 100 volts H.T. and zero grid bias

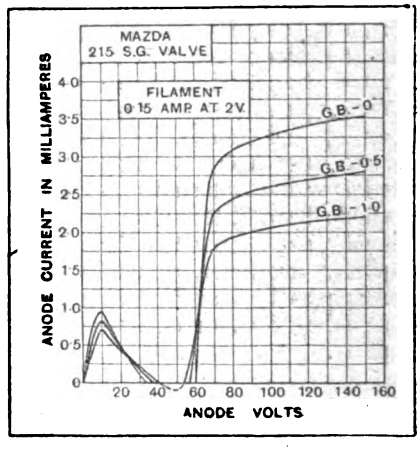


Average values under working conditions; A.C. resistance 2,100 ohms; amplification factor, 6.9; mutual conductance, 3.3 mA/volt.

gave values sensibly in agreement with these. We found the A.C. resistance to be 1,820 ohms, the amplification factor 6.6, and the mutual conductance 3.26 mA. per volt.

Type 215 SG.

This is undoubtedly the star valve in the series. It is a screen-grid H.F. amplifier, and to obtain full value from the characteristics exhibited careful design of the H.F. stage and associated circuit will be necessary. A mutual conductance of 1.1 mA. per volt has been achieved, coupled with an amplification factor of 300 and an A.C. resistance 270,000 ohms, according to the maker's rating. Measurements made with a sample 215 SG under the same conditions, namely, 120 volts H.T., 60 volts screen-potential, and zero grid bias, gave the values as: A.C. resistance 246,000 ohms, amplification factor



Average values under working conditions; A.C. resistance, 246,000 ohms; amplification factor, 293; mutual conductance, 1.19 mA/volt.

293, and mutual conductance 1.19 mA./volt.

Since the A.C. resistance is of the order of that of a well-designed and efficient tuned circuit at resonance, set designers may justifiably expect a big stage gain if adequate attention to small details in the design of the stage is followed. According to the maker's figures the effective inter-electrode capacity has been reduced to about one-third of that obtaining in the majority of similar tetrodes.

This should make for greater stability and higher amplification from a single stage than possible hitherto with battery-fed filament valves.

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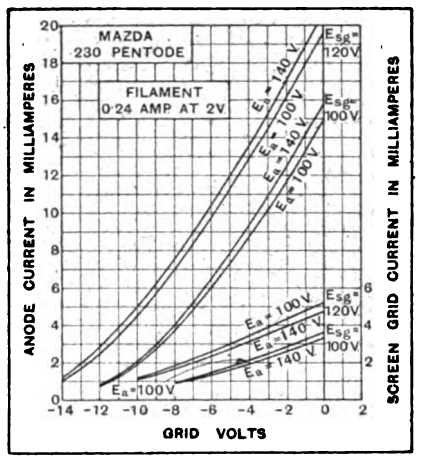
Valves we have Tested.—

Type 230 Pen.

This is a five-electrode power valve with a high amplification factor, but, unlike the majority of power valves, will not handle a large input. The use of an intermediate L.F. stage between the detector and the pentode output valve is not recommended. Its greatest field of usefulness will be found probably in portable sets where space is limited and low H.T. consumption essential.

Maker's figures are not yet available regarding the characteristics of the valve, but we have measured these under various conditions and find that with 100 volts on both anode and auxiliary grid, and at zero grid bias, the average values are: A.C. resistance 49,000 ohms, amplification factor 84.5, and mutual conductance 1.73 mA. per volt. These vary considerably with different values of anode potential, auxiliary grid volts, and grid bias.



Average values under working conditions with auxiliary grid potential lower than anode voltage; A.C. resistance, 80,000 ohms; amplification factor, 112; mutual conductance, 1.4 mA/volt.

It is noticed on examination of the valve that the "earthed" grid, or fifth electrode, is connected internally to the control-grid, and not to the filament as usual in valves of this type. A standard 4-pin base is fitted with the pins disposed as in the ordinary triode. The auxiliary grid is brought out to a small terminal on the side of the base.

All valves in this series are heavily "gettered," and we could not find the slightest trace of softening as evidenced by the presence of reversed grid current.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

EMPIRE BROADCASTING.

Sir,—I am glad to see that some of the complaints concerning the class of items broadcast by the B.B.C. from 5SW have been published in your esteemed journal from time to time, and am sure overseas readers will thank you for your interest.

Of course, we overseas readers and listeners realise that we are free listeners and have no right to complain. Certainly the "High and Mighty Powers that Be" could give us a very disconcerting reply. However, it is understood that 5SW is an Empire Station for world-wide transmissions.

The present policy of 5SW is very unsatisfactory to the Empire, and other listeners. Here in Egypt, as undoubtedly elsewhere, there are many foreign listeners who would be far more interested in the British Empire if 5SW made its programme more interesting and more musical. Does this awful drama stuff amuse anyone? I think there is quite enough trouble in our daily rounds without adding to it by sitting down to listen to such things as "Ah! after five years of prison I am at last f-r-r-ee!" How many people want pianoforte lessons per radio? How many are content to listen to lectures? Let us be gay, cheer us up, amuse us, and we commence the next day with a brighter outlook and a kindly thought.

It is a great pity that there are no transmissions on Saturdays and Sundays. They are the best times for busy overseas listeners.

If I lived at Home I would approach the wireless clubs. Through them and their politicians the B.B.C. could be controlled by listeners. Another suggestion is that the B.B.C. have a committee of listeners, formed from delegates of the wireless clubs, to consult on programmes. Correspondence can also be a fair census of what is required.

Incidentally, our politicians would be serving our Mother Country far better if they "washed their linen" at home, instead of getting on the air and telling foreign listeners what fools, bunglers and prevaricators are the other political parties does not improve our prestige. Overseas listeners cannot vote. Their only interest in Home politics is the result, and we were not allowed to have the result broadcast to us!

We are entitled to hear urgent news. For instance, everybody is interested in His Majesty's health. Yet whilst all other countries are broadcasting news, the B.B.C. muddle along. Other countries are coming on the air with very powerful S.W. transmissions, whilst we still have our "experimental." Does this mean nothing to the Government and the B.B.C.?

Alexandria, Egypt. "MAHANDIS."

A NUT CONVENTION.

Sir,—With reference to "Mahandis'" letter in *The Wireless World* of July 31st regarding hexagonal terminal nuts, we would advise that we have fitted hexagonal nuts with slot for screwdriver to the whole range of our components for some considerable time. We are in entire agreement with "Mahandis" that the multitude of various forms and sizes of milled-edge terminals are totally unsuited for radio components. The hexagonal nuts permit the use of a flat or box spanner and also a screwdriver for those cases where nuts are in inaccessible positions. BURNE-JONES AND CO., LTD.

AMATEUR STATUS.

Sir,—I think that all amateur transmitters of this country will be grateful to you for your championship of their cause, and I hope it will result in some much-needed improvements, as did your crusade for Empire broadcasting.

There is one point, however, which should not be overlooked; the 20- and 40-metre wavebands are hopelessly overcrowded, even from the point of view of European stations. One can but vaguely surmise the conditions at the other side of the Atlantic, where there are 17,000 licensed amateurs in the United States alone. Since the new regulations came into force communication with America on 42 metres has been almost impossible. On 21 metres it is rarely possible to converse with an American unless he is able to report signals at least R5. Even an "R6" or "R7" report is frequently followed by "Sorry, interference bad, please repeat." On the other hand, the 5-, 10- and 160-metre bands are almost deserted. I would suggest therefore that, in the interest of amateur radio as a whole, the 21- and 42-metre wavebands should be reserved for those who wish to undertake serious work of an experimental nature.

Most other work which might warrant the granting of a transmitting permit could be done on the 80- and 160-metre wavebands, and it is to be hoped that the authorities will

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remove some of the "red-tape" restrictions at present imposed; such work, for instance, as Army-amateur co-operation should receive every encouragement, and there is no really valid reason why "traffic" should not be allowed in this country, as in the U.S.A., provided it is kept off the 20- and 40-metre "DX" bands.

Another amateur activity which could do with some encouragement is the development of waves below 10 metres. At present these waves have no commercial use, neither have amateurs shown overmuch interest in them. If such an interest could be stimulated, instead of limited by restrictions, it would not only reduce the congestion on other wavebands, but might well lead to remarkable developments. When a use has been found for these waves it will be time enough to introduce restrictions; in the meantime, I would suggest that all amateurs be granted the use of 160 and 80 metres and *all* waves below 10 metres—the latter *free from all restrictions;* but that special justification should be shown for the use of the 20- and 40-metre bands. L. A. MOXON (G6XN).

Hampstead, N.W.6.

Sir,—Having followed with much interest the correspondence which has recently appeared in *The Wireless World* with regard to amateur status might I be permitted to occupy a little of your valuable space in voicing the opinions of several amateur transmitters, including myself?

First, the present conditions under which transmitting permits are issued, severe though they be, give considerable freedom of operating to amateurs. In this connection the R.S.G.B. should be congratulated on having obtained more or less reasonable terms from the Post Office.

There is, in fact, little wrong with the R.S.G.B., except perhaps a certain amount of snobbishness which everyone notices in a small number of officials of the R.S.G.B. in London. This evil could be remedied by the retirement of the snobs, who, though in a minority, make themselves known and heard only too well. Persons well-versed in the technicalities of radio should not regard with scorn those less technical.

It is foolish to believe that there is any society in Great Britain so representative of amateur interests as the R.S.G.B., and all that is needed is a little more cameraderie and individual help. ETHERIS.

London.

TELEVISION.

Sir,—By a peculiar coincidence I happened to be looking over your back number of July 18, 1928, where the following note under "Current Topics" caught my eye:—

"Mr. Samuel Izenstark, described as 'the pioneer of wireless manufacture in America,' prophesied last week that television sets will be installed in 14,000,000 homes in America within the next twelve months."

It would be interesting to know how near this optimistic dream is to its fulfilment in America, now that exactly a year has elapsed since this statement was uttered.

One mustn't outdo Jules Verne.

Paris. RONALD A. BRADFORD.

THE ULTRA-MICROSCOPE.

Sir,—I would like to comment on the reference to the ultra-microscope on page 135 of the issue of August 7th.

If blue-green light ($500\mu\mu$) just shows the shapes of certain particles, then extreme ultra-violet ($100\mu\mu$) will show the shapes of particles five times smaller in diameter (I believe that $100\mu\mu$ is about the limit). But that is only a high-frequency amplification of five times; it is not ultra-microscopy, for the particles can still be seen; the ultra-microscope locates the position of particles that are too small to be seen by any light! Possibly it is a frequency-changer: I am not sure. Given fluorescence, yes.

A lamp filament three yards away may be invisible when cold. When glowing, though its position is indicated, it is still invisible! Though it seems a bit thick, yet, like the stoutness that is beauty in Africa, the thickness is in the eye of the beholder.

We know that Saturn wears a red flannel belt summer and winter: he is big enough and near enough to be seen. But we do not know whether Sirius wears the regulation collar, for he cannot be seen; but he emits light by which he is located.

In the ultra-microscope, particles are strongly illuminated against a dark ground. They glisten. Their shapes are not seen—they are too small; only blobs of light show where they are.

Incidentally, two microscopes in cascade do not constitute an ultra-microscope. M2 is only a low-frequency stage: it cannot amplify detail that is not already shown by M1, nor position either.

If there were lumps in the ether, and we sprayed them with short waves . . . W. RAWSTHORNE.

Hadfield, Derbyshire.

RECENT RECORDS OF INTEREST.

VERY few wireless sets of to-day are considered complete unless provision is made for using a gramophone pick up in conjunction with the amplifier and loud speaker for the electrical reproduction of gramophone records. It is, therefore, natural that the user of a wireless set is becoming more and more interested in the products of the various record manufacturers.

Columbia has recently produced some interesting works. Perhaps one of the most important is the Thanksgiving Record, reproducing some of the music as rendered by the Choir of St. George's Chapel, Windsor, on the occasion of the Thanksgiving Service for the recovery of His Majesty the King. This is not only a very beautiful record, but is also a memento of an historic occasion. On the reverse of this record (No. 9808, Columbia 12in.) we have the Coronation Offertorium—"O Hearken Thou unto the Voice of My Calling"—beautifully rendered by the same choir.

Lovers of opera will welcome the new Columbia 12in. record, No. 9654, which gives a fine rendering of the beautiful duet between Pinkerton and Butterfly at the close of the first act of Puccini's ever-popular opera; the singers are Isobel Baillie and Francis Russell. The most exacting purist can hardly object to "Madame Butterfly" being sung in English, as the principal characters represented would naturally speak in our language. On the reverse side Miss Baillie's clear soprano blends effectively with Miss Nellie Walker's contralto in the Barcarolle from Offenbach's "Tales of Hoffman."

Another fine record (Columbia 5466, 10in.) is that of Brahms' Hungarian Dances, Nos. 5 and 6, as played by the Hallé Orchestra in the Free Trade Hall, Manchester, and conducted by Sir Hamilton Harty.

A most remarkable piano record is Percy Grainger's rendering of "Shepherd's Hey" and "Country Gardens," which are recorded on Columbia 10in. No. D. 1664. Those who have not heard these pieces will be amazed at the variety of tone which Percy Grainger is able to obtain from the piano, and the result is distinctly invigorating, if music may be so described.

As a real test for the high-note performance of a pick-up amplifier and loud speaker we commend to our readers a duet for two piccolos, entitled "The Merry Brothers," by Jean and Pierre Gennin, Columbia 12in., No. 9821, on the reverse side of which is recorded "Echoes of the Valley," a duet for flute and echo flute. The former of these pieces would, we venture to think, open the eyes (or rather ears) of many a listener to the shortcomings of his equipment so far as high notes are concerned.

Among the recent fox-trots and other dance music may be mentioned the following Columbia records:—No. 5484, "When my Dreams come True" and "Reaching for Someone and not Finding Anyone," played by Paul Whiteman and his Orchestra, and No. 5482, "Excuse Me, Lady" and "Huggable, Kissable You," as played by the B.B.C. Dance Orchestra, conducted and led by Jack Payne.

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READERS' PROBLEMS

ANSWERED

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

"The Wireless World" Supplies a Free Service of Technical Information.

Short-circuiting or Condenser Charging?

A spark due to the flow of charging current into the large by-pass condensers is generally produced when the H.T. battery is connected to my receiver. I am quite familiar with this effect and have come to expect it; consequently, when I recently connected up my batteries to a set in which there happened to be an accidental short-circuit across the H.T. terminals, I did not take much notice of the fact that the spark was rather more intense than usual. The fact that the H.T. battery was ruined has taught me to be more careful in future. Is there any easy way of telling whether the spark is normal or whether it is due to an excessive flow of current through a partial short-circuit? S. E. C.

There is a very easy way of determining this point; all that is necessary is to tap the connecting lead lightly on the terminal and observe if the usual spark takes place. Then make contact again and observe if another spark is produced. If it is *not*, it can be assumed that the condensers are fully charged up and that there is no appreciable leakage.

Of course, the valve filament switch should not be "on" while this test is being made.

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A Simple Two-circuit Tuner.

You have given your blessing (in the "Readers' Problems" section) to the use of the "Flat Dwellers' A.C. Three" with an open aerial, but have stated that when modified in this way the set will not be highly selective. It seems to me that its performance in this respect should be quite satisfactory if a separately tuned aerial circuit, loosely coupled to the grid coil, were used. Will you please suggest the simplest possible arrangement likely to be effective? C. D. S.

Your proposed scheme of modification is a good one, and the selectivity afforded by a properly designed two-circuit tuner, even with optimum aerial coupling, should be sufficient for average requirements. Further, thanks to the high amplification afforded by the H.F stage, it will be possible to obtain sensitivity above the average when aerial coupling is reduced well below the value giving loudest signals, and consequetly the set should be found satisfactory in situations where interference is intense.

A simple but satisfactory form of connection is shown in Fig 1. In this diagram, L and L_1 are respectively medium- and long-wave aerial loading coils. The latter is short-circuited when required by the left-hand blade of the three-pole switch. The middle blade of this switch transfers the loaded aerial connection to a tapping point near the earthed end of the appropriate grid coil L_2 or L_3. The latter (the long-wave winding) is short-circuited by the right-hand switch blade when it is in the "up" position.

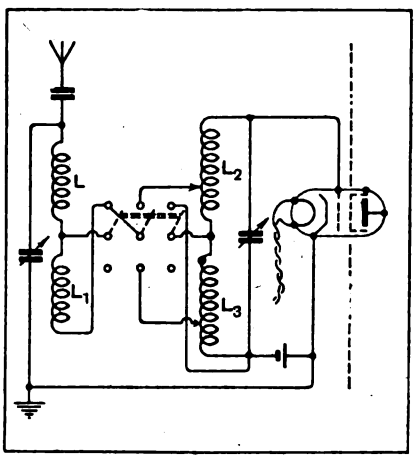

Fig. 1.—A simple auto-coupled aerial tuner for the "Flat Dwellers' A.C. Three." A screen should be interposed between the aerial coils and the grid inductances.

You will observe that a series fixed condenser is inserted in the aerial circuit. This is optional, but will generally be of advantage, as it enables one to cover the normal broadcast band with a single aerial loading coil and a variable tuning condenser of 0.0005 mfd

oooo

"The Foreign Listeners' Four."

Will you please tell me the name of the makers of the special indirectly heated S.G. high-frequency valves used in "The Foreign Listeners' Four"?

The S.V.4 valves are manufactured by the Mullard Company, which also produces the type 164.V. triode used as a detector in this set.

oooo

An Awkward D.C. Voltage.

I am in the unfortunate position of having a D.C. supply of 150 volts only, and am doubtful whether I shall be able to obtain sufficient voltage for the output stage to ensure good quality at reasonable volume. If I decide to make up an H.T. eliminator, can you give me any idea as to what voltage will be lost in the smoothing devices? W. S. R.

Without knowing the anode current consumption of your output valve we cannot say exactly what voltage will be "dropped" in the smoothing circuits; but if you choose a good choke with a low D.C. resistance there is little reason why you should lose more than some 15 volts. This means some 135 volts will be available for the set.

oooo

A Correction.

In the description of the "New Kilo-Mag Four," the maximum value of the volume control resistance is given as 200,000 ohms in the inscription under Fig. 2, and as 20,000 ohms in the "List of Parts." Which is correct? T. C.

A maximum value of 200,000 ohms is suitable, and consequently the figure given in the "List of Parts" is incorrect. This error is regretted.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Test the Grid Leak.

My "New All Wave Four" has worked well until recently; it now seems to become choked, signals failing almost completely for an appreciable time and then coming back to original volume. Can you tell me what is wrong? W. T. D.

If the "choking" coincides with the reception of a signal of exceptional strength (or of a strong atmospheric discharge), your description of the trouble would lead us to think that it must be due to a faulty grid leak (in the first L.F. grid circuit), and in all probability the replacement of this component will put matters right. If it does not, it must be assumed that the trouble is not due to true grid choking, and it will be necessary to make careful stage-by-stage and point-to-point tests, in order to locate an intermittent partial disconnection.

oooo

Picture Reception.

I have built the Picture Receiver described in January, and for some time it worked perfectly, but lately some fault seems to have developed which makes the picture blurred. I enclose specimen pictures, including one received from Berlin. W. A.

The trouble you are experiencing with your picture receiver is no doubt due to an incorrect adjustment of friction. Excessive friction causes a serious retarding of the clockwork drive giving a varying speed of starting on release. Insufficient friction gives a poor start when the catch is withdrawn. Carefully reset the catch plate and critically readjust the friction plungers so that there is no change in the running of the governor with stopping and starting. Look also to the friction pad of the governor, as well as the centre mountings of the spindle.

(a) Wavy line produced by an incorrect adjustment of friction. (b) Picture from Berlin submitted by querist.

Two A.C. H.F. Stages.

Would it be possible to use A.C. valves throughout in the "Kilo-Mag Four," making only the obvious modifications and adding the necessary cathode and heater connections? S. E. L.

This receiver could be operated with A.C. valves, but some adjustment, particularly of the H.F. transformer ratios, would be necessary, and unless you have had a good deal of experience of multi-stage H.F. amplifiers, we think you would be safer in adopting something on the lines of the "Foreign Listeners Four," which is specially designed for indirectly heated valves.

oooo

Grid Bias for H.F. Valves.

On page 108 of your issue for July 31st it is stated that the sensitivity of an S.G. high-frequency amplifying valve can be improved by fitting a potentiometer so that grid bias may be adjusted to the minimum value necessary to prevent the flow of grid current under the influence of signals. Can it be taken that a similar refinement is of benefit where a neutralised triode is in question? W. P.

The mutual conductance of any valve will be improved by operating it with the minimum negative grid voltage required for the purpose on hand, and it is a fact that the performance of a neutralised triode H.F. amplifier can often be improved by making provision for critical control of grid bias. Unless the voltage applied from the usual dry cell (or cells) happens to be unusually wide of the mark, however, it is unlikely that the addition of this refinement will yield a readily perceptible increase in signal strength.

Where Reaction Cannot be Used.

Is it possible to apply reaction to the "Multiple Valve Portable," and, if so, will you please tell me how to proceed? H. R. F.

In the multiple valve used in this receiver no connection is led out from the anode of the detector valve element, and consequently any conventional form of reaction is out of the question. In point of fact, it is possible to increase sensitivity by passing back to the detector, grid circuit a certain amount of energy from the output valve element anode circuit (in which a certain amount of H.F. energy is flowing), but this course is hardly to be recommended.

oooo

Indirectly Heated Cathodes.

As a new reader of your journal, I cannot understand how indirectly heated valves derive their low tension current from the mains, nor can I see in what respect they differ radically from battery valves. Can you give me a few words of explanation, particularly with regard to the latter point? J. F.

Indirectly heated A.C. valves are fed with low-tension current through a step-down transformer—generally providing about 4 volts—connected to the A.C. mains. The filament through which A.C. current is passed is not the emitter or cathode in the ordinary sense of the word, but serves merely to heat another element (the cathode proper), which is placed in close proximity to it, and is chemically coated or otherwise treated so that it provides a copious emission of electrons at a comparatively low temperature. This cathode serves the purpose of a filament in an ordinary valve, but only one connection from it is led out from the interior of the glass bulb.

oooo

Short Wave Aerial Coupling.

I have made a 2-valve det.-L.F. short-wave set on conventional lines, the general design following that of circuits discussed in "The Wireless World." It works quite well, but I find that over the majority of the waveband covered results are distinctly better when the earth connection is completely removed. Does this indicate that there is a fault? M. S. D.

When a short-wave set works best with the earth disconnected, it can generally be assumed that it does not include provision for a sufficiently loose aerial coupling. We think that attention to this point will put matters right; although a short-wave set may work quite well without an "earth," hand capacity effects are likely to be less troublesome when this connection is included.

If your set includes a separate aerial winding with variable coupling to the grid coil you should make provision for a weaker coupling than at present, and, if necessary, remove some of the aerial turns; if an auto-transformer arrangement is used, provision must be made for connecting the aerial nearer to the earth point.

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(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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HIGH-FREQUENCY AMPLIFICATION.

Where We Stand To-day.

THE importance of high-frequency stages in broadcast receiving apparatus in this country will undoubtedly be emphasised as soon as the stations of the Regional Scheme begin to come into operation. Brookman's Park, the first of the regional stations, we now learn will commence an hour's transmission every night at the close of the normal 2LO programme as from September 16th, and it will not take long, we think, to convince those whose present receivers are unselective, or who lack a high-frequency stage capable of giving good selectivity, that a change of receiver or substantial alterations to their existing sets will be necessary. After four weeks of more or less experimental transmissions it is anticipated that Brookman's Park will be ready to take over from the Oxford Street transmitter 2LO, and the latter station will then close down. The alternative transmission from Brookman's Park, when two programmes will be radiated from the same transmitter, will probably come into operation at the end of the year.

Progress in H.F. Amplification.

It is in the direction of increasing high-frequency amplification that the greatest progress has been made in connection with the design of receivers for broadcast reception during the past twelve months. The series of receiver designs now appearing in *The Wireless World* establish new records in sensitivity and selectivity. The valve manufacturers have devoted much attention to producing screened high-frequency valves for both mains or battery operation, some having, as we have seen from information published in *The Wireless World*, astonishing characteristics. It is by designing the H.F. stage around these valves that it has been possible to obtain the degree of amplification which reaches the high-water mark in *The Wireless World* "Record III" described in this issue.

The series of receivers now being described in this journal are indebted for performance to the incorporation of many of the technical points introduced to the wireless public through articles which have appeared in the pages of the journal during the past few months. Readers will recollect the care with which questions of complete screening, decoupling schemes, and the design of H.F. transformers have been discussed and explained by various contributors. We must admit that making the most of these points, so as to attain the utmost in efficiency, entails great care not only in design but also in the final execution by the constructor.

New Season's Sets and the Regional Scheme.

The changes which the introduction of the Regional Scheme will bring about in the conditions of reception in this country will, we believe, be reflected in the design of receivers which will be on show at the forthcoming Olympia Exhibition, and we would be inclined to prophesy that the price of sets suitable for use under the Regional Scheme will not show a reduction as compared with sets of last season.

To justify this statement we must explain a little more fully what is meant. The Regional Scheme demands that receivers should be far more selective than has been necessary in the past, and in order to achieve this increase in selectivity it becomes necessary to employ two H.F. stages, or, if one H.F. stage, then additional tuning equipment must be included. This in itself seems to indicate an increase in the number of valves over what has been necessary in the past, whilst we must also take into consideration that, from a manufacturing point of view, the production of sets embodying efficiently tuned H.F. stages entails a great deal of additional work, and these points we can hardly expect to be introduced without affecting the selling price of the receivers

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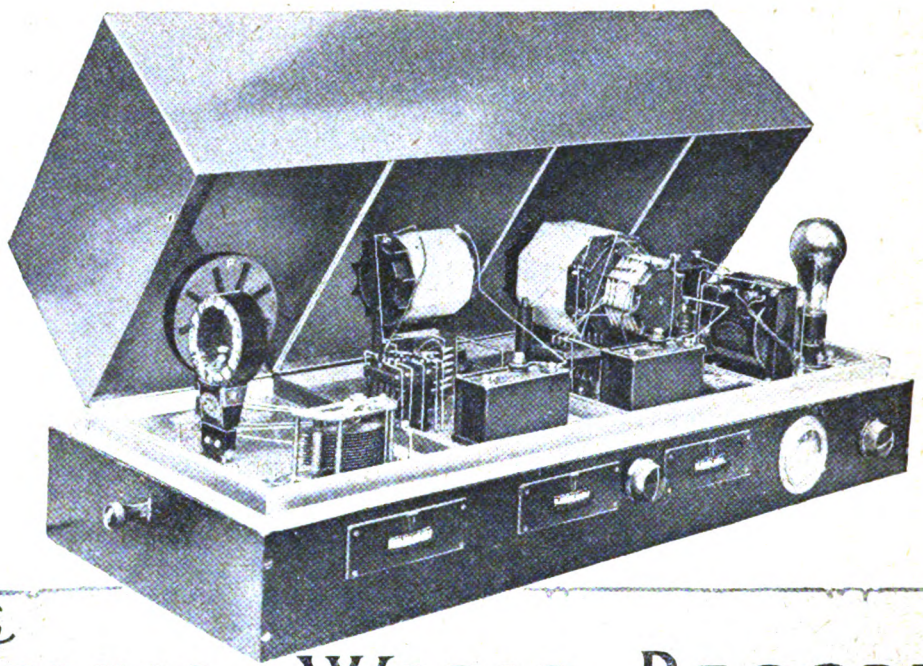

The WIRELESS WORLD RECORD III

The Highest H.F. Stage Gain Yet Attained.

By A. L. M. SOWERBY, M.Sc., and H. F. SMITH.

THE advances that have been made in valve design in the last year or two, together with an increasing appreciation of the best mode of making use of them in a receiver, have made it possible to produce a three-valve set that gives a performance quite equal to that of the very best four-valve receiver of a year or two ago. The single H.F. stage gain of 500, which is claimed, is unprecedented.

To attain this high efficiency, however, while at the same time keeping the quality of reproduction well up to the requirements of modern standards, it is absolutely essential to employ the most highly efficient valve obtainable, and to pay the very closest attention to the reduction of all sources of loss in the high-frequency circuits. Apart from these two points the design of a receiver may well follow established practice, so that its construction need offer no greater difficulties than are associated with the careful building of any other set.

It will not be news to any regular reader of *The Wireless World* that valves with indirectly heated cathodes are of higher efficiency than those of normal type, while it is also well known that the " short-path " type of construction, in which cathode, grid and plate are all very close together, also adds considerably to the amplification attainable from a valve. For these two reasons the Cosmos A.C. type valves, which are intended to be heated, through a step-down transformer, from alternating current mains, and which employ the " short-path " construction, have been chosen for this receiver, which sets out to reach the high-water mark of attainable amplification. The receiver, of which photographs and diagrams accompany this article, has been designed to suit these particular valves, and though it is never fair to a set to use in it valves other than those for which it is designed, in the present case it would result in a complete failure to reach the expected standard of sensitivity.

The Wireless World *established a record with the three-electrode valve by obtaining an H.F. stage magnification of 40;* The Wireless World *Record* III *set, described in the accompanying text, gives no less an H.F. stage magnification than 500, thus setting a new standard in receiver design. With a balanced screen-grid amplifier and three A.C. valves, the most advanced practice in radio design is represented.*

The ideal receiver has long been known to be that in which the bulk of the amplification necessary for the reproduction at loud speaker strength of signals from distant stations is performed before rather than after the detector. Detectors in general, and the anode-bend detector in particular, such as is used in this set, has some approach to a " square-law " response curve, in that the signal-strength, expressed in terms of volts of rectified audio-frequency, is more or less proportional to the square of

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The Wireless World Record III.—

the high-frequency voltage applied to the detector. As a result of this, an amplification of ten times at high-frequency adds, very roughly speaking, as much to the signal-strength as an amplification of a hundred times at low frequency. Since an amplification of, say, 30 to 40 times in a single high-frequency stage is quite easily attained, while it is impossible to make a stage of low-frequency amplify by the equivalent 900 or 1,600 times, it is going to pay us to amplify as much as possible before rectification and as little as need be afterwards.

It is not possible, at present, to make the detector valve operate the loud speaker, so that in any receiver, even if this view is carried to its logical conclusion, the detector will have to be followed by a suitable output valve; there will, however, be no low-frequency amplifier between the two.

One and Two H.F. Stages Compared.

Until recently it has not been possible to dispense in this way with low-frequency amplification while still retaining sensitivity enough to receive distant stations at good strength on an aerial of only moderate excellence except when two stages of high-frequency amplification could be used to make up the necessary input to the detector, for with only one stage it is not usually possible to amplify the small signal-voltages from distant stations to a sufficient extent. Though there is no reason whatever why two stages should not be employed, it does undoubtedly necessitate the use of very extensive screening, and in addition there still lingers the old belief, though there is no longer very much justification for it, that two stages are very difficult to set up and adjust. Those, however, who have had the opportunity of handling a two-stage set such as the " Kilo-Mag Four " will realise the truth of the suggestion already made that a receiver in which the bulk of the amplification is done at high-frequency takes a good deal of improving upon.

By the use of an indirectly heated screen-grid valve of exceptionally high efficiency in the receiver here described, a close approach to the very desirable characteristics of a receiver containing two high-frequency stages has been attained, while employing a single stage only. It has not been possible, even by the elimination of all sources of loss that were open to removal by simple means, to push the amplification of the single stage quite up to that attainable by two ordinary stages in cascade,

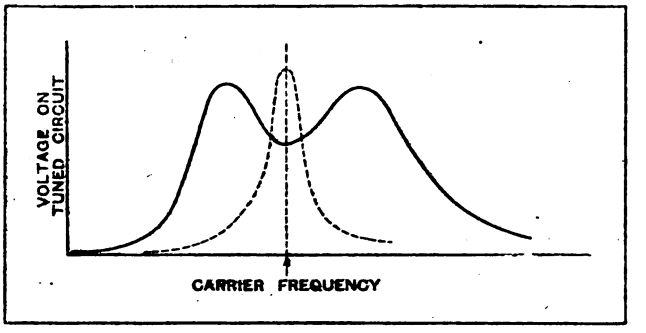

Fig. 2.—The joint resonance curve of the first two (coupled) tuned circuits is of the type shown in full line, accentuating the side-bands. The intervalve coupling has a resonance curve of the type shown by the dotted line.

but the use of indirectly heated valves in the detector and output positions goes far to camouflage the difference that still remains.

Reference to Fig. 1, in which is shown the circuit diagram of the receiver shorn of all such trimmings as waveband switching, will show the main lines along which the receiver has been built, and will be used as a basis for the discussion of the salient features of the design.

The first information yielded by a glance at the diagram is that three tuned circuits are employed, and that, since the detector operates on the anode-bend principle, no provision is made for reaction. The use of an anode-bend rectifier, in conjunction with a tuned circuit of the lowest attainable losses, makes the use of reaction completely unnecessary. The sole legitimate purpose of reaction is to keep the losses in the detector grid circuit down to a low value over the whole tuning range, nullifying the damping due to a grid rectifier, if such is used, and making up for any undue natural losses that the tuned circuit may possess owing to its slovenly design or construction. In the present receiver these same results are attained, once for all, in the building of the set; the grid-circuit of the detector has been designed for the lowest losses compatible with quality, taking into consideration the slight damping due to the anode detector.

Apart from the fact that the reaction control is always

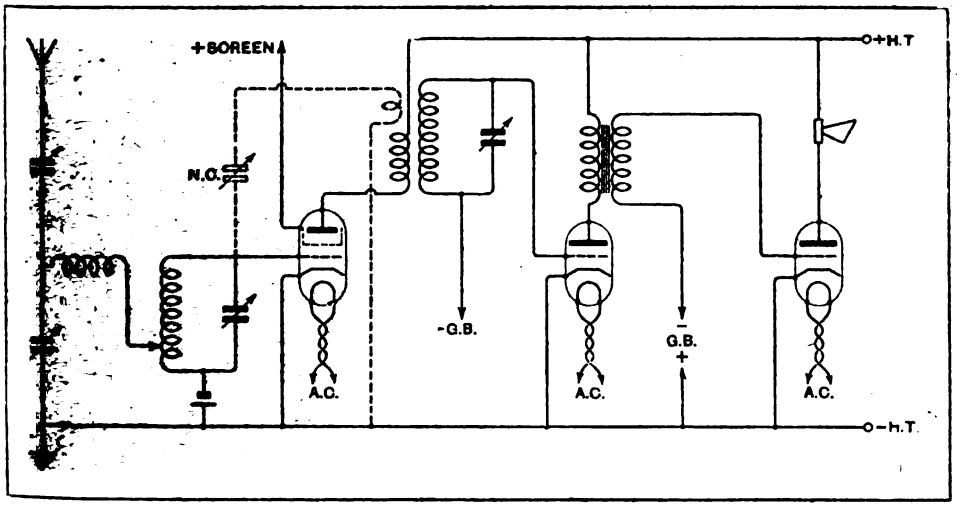

Fig. 1.—Simplified circuit diagram without decoupling devices, screening, waveband switching, etc. The neutralising circuit is shown in dotted lines.

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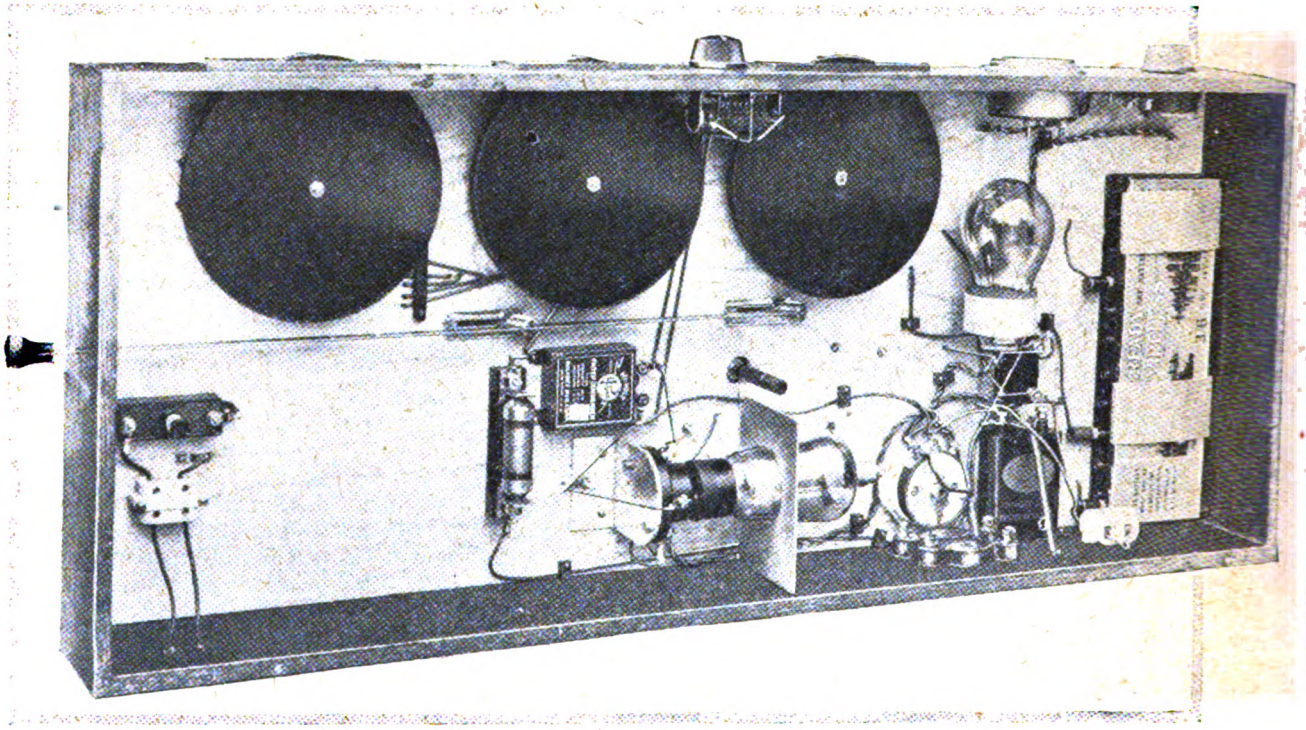
The Wireless World Record III.—

an irritation, in that its setting depends on the operating voltages applied to the detector valve, and bears no rational relationship to the wavelength of signals being received, its disappearance has made it possible to introduce a third tuned circuit in the form of a loose-coupler without exceeding the usual number of three operating controls. As a result the selectivity of the receiver is raised to a standard that is, if anything, higher than that of a set of the 2HF class, and it is handled in exactly the same way.

Aerial and secondary coils are coupled by making a few turns of the grid-winding common to the aerial circuit on long waves, and by winding over the secondary a few turns in series with the aerial coil on short waves. In order that there shall be no coupling between the coils other than that intended, the coils are screened from one another by being placed in separate compartments of the screening-box. Without some precaution of this sort most of the benefit conferred by the extra tuning control is lost. Complete screening at this point is, strictly speaking, unnecessary, but it is quite essential between grid and plate circuits of the H.F. valve. After extended trials with conventional methods of construction the writers decided to have the set rebuilt in a standard container of the type advocated in this journal—not because stability was unattainable with an ordinary layout, but because its realisation involved so many constructional complications that the set was by no means easy to build.



View of the components attached to the underside of the baseboard. On the right can be seen the decapped detector valve in a special mounting which can be modified to accommodate individual bulbs.

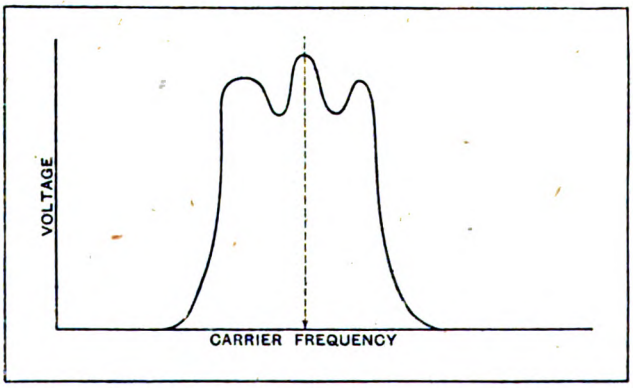


Fig. 3.—This gives the resultant of two curves such as those of Fig. 2, and shows how the use of coupled circuits tends to decrease high-note loss due to cutting side-bands, while improving the overall selectivity.

The fact that the rebuilt set proved satisfactory from the outset would seem to promise well for the future of the new containers; at any rate, the writers are now fervent advocates of this method of construction, as they are satisfied that it affords the easiest way of attaining maximum amplification without instability.

It might be thought that the introduction of the third tuned circuit would result in accentuating to an intolerable degree the loss of high notes that occurs when tuning is over-sharp. As a matter of fact, this is not the case, for when two tuned circuits are coupled together directly, and not through a valve, their resonance curves are no longer independent. As a result, a new type of resonance curve, of the type shown in full line in Fig. 2, makes its appearance. This curve, which is the joint resonance curve of the two circuits, has two maxima situated one on each side of the carrier frequency of the station being received, and so produces

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The Wireless World Record III.—

accentuation of the side-bands at the expense of the carrier. In distinction to this, the intervalve circuit provides a normal resonance curve accentuating the carrier at the expense of the side-bands, as indicated by the dotted curve of Fig. 2. The resultant of the two curves, which represents the overall high-frequency response curve of the receiver as a whole, takes some such form as that shown in Fig. 3. This, while by no means perfect, yet makes a closer approximation than is usually attained to the ideal flat-topped curve that would represent high selectivity with no loss of side-bands.

In accordance with this it is found that the receiver combines high-note reproduction with selectivity to an unusual degree. Quantitative figures in this respect cannot usefully be given, as the position and magnitude of the maxima of the double-humped curve vary with the tuning of the aerial and secondary circuits.

Detector Considerations.

The choice of an anode detector, which we have seen to be necessary if we wish to provide the maximum selectivity with the minimum number of controls, presupposes that the amplification at high-frequency shall be great enough to provide that valve with the rather high input-voltage that it requires for satisfactory rectification. The present receiver does not fail in this respect since, as has already been indicated, the amplification it provides in its single stage approaches closely that normally associated with two stages of well-designed high-frequency amplification.

The design of the high-frequency stage for the broadcast wave-band has already been outlined in an article by one of the writers,[1] and to this is referred any reader who is interested in the technical details of the intervalve circuit used. The figures given in that article for

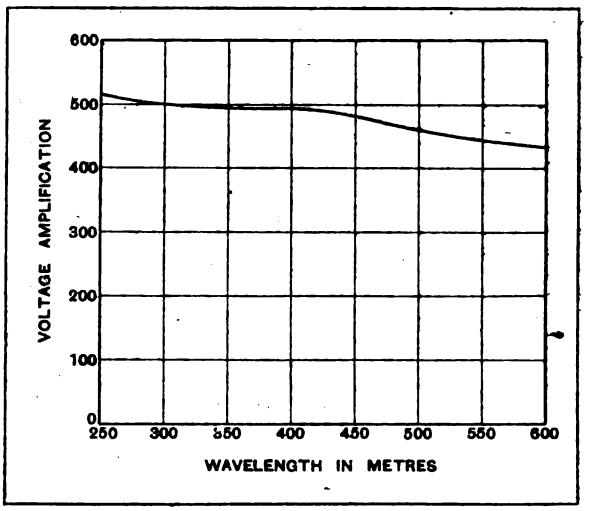


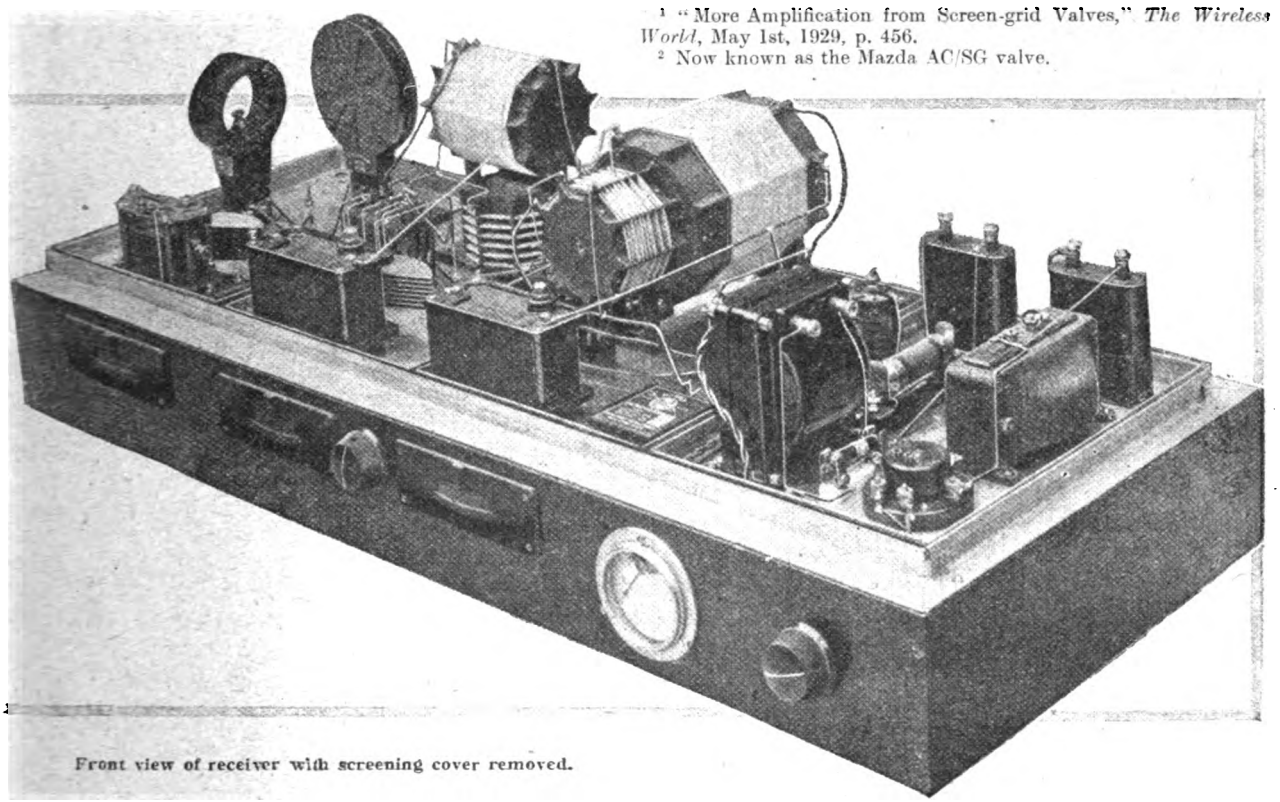
Fig. 4.—High and uniform H.F. magnification over the whole broadcast band is an outstanding feature of the receiver. The measured amplification is shown by this curve.

amplification, however, are wrong, being based on the characteristics of an early sample valve which was by no means up to the standard of those put on the market when the valve was released for general purchase.

Measurements made with three AC/S valves[2] that had

[1] "More Amplification from Screen-grid Valves," *The Wireless World*, May 1st, 1929, p. 456.

[2] Now known as the Mazda AC/SG valve.



Front view of receiver with screening cover removed.

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LIST OF PARTS.

1 Variable condenser, 0.0005 mfd. (Lotus Log.).
2 Variable condensers, 0.0003 mfd. (Burndept Log.).
1 Neutrovernier (Gambrell).
3 Fixed condensers, 2 mfd. (Ferranti C_2).
3 Fixed condensers, 0.1 mfd. non-inductive (Polymet).
1 Fixed condenser, 0.0005 mfd. (Dubilier No. 620).
2 Fixed condensers, 0.005 mfd. (C.D.M.).
1 Semi-variable condenser (Formo, Type J).
1 Switch, 4-pole D.T. (Utility Lever pattern).
1 Switch, 3-pole D.T. (Utility Lever pattern).
2 Single coil holders (Lotus).
1 Resistance, wire-wound, 10,000 ohms, and holder (Ferranti).
1 Resistance, wire-wound, 20,000 ohms, and holder (Ferranti).
1 Grid leak type resistance, 10,000 ohms (Loewe).
1 Grid leak type resistance, 100,000 ohms (Loewe).
2 Porcelain holders for above (Bulgin).
1 Decoupling resistance, 600 ohms (Wearite).
1 Potentiometer, 400 ohms (Igranic, porcelain).
1 Truvolt variable resistance, 50,000 ohms (Rothermel).
1 Electrad Royalty resistance, 200,000 ohms (Rothermel).
2 A.C. valve holders (Met-Vick).
2 Porcelain 2-way connectors (Athol).
1 Grid bias battery, 16½-volt (Ever-Ready).
1 Single dry cell (Ever-Ready, "O" size).
1 Ribbed ebonite former, 4in. dia. × 4½in. long (Redfern).
1 Ribbed ebonite former, 3in. dia. × 3½in. long, 9 ribs (Becol).
2 Ribbed ebonite formers, 3in. dia. × 2in. long, 9 ribs (Becol).
1 H.F. Choke (Climax).
1 L.F. transformer (Ferranti A.F.5).
1 L.F. choke, 32 henrys (Pye).
1 Meter, 0–2 mA. (Sifam).
3 Wander plugs (Lisenin).
1 Special metal container.
3 Special dials.
Ebonite, wire, Systoflex, screws, etc.
Approximate cost, excluding cabinet, coils and dials, £10 10s.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed, and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

been specially sent by the makers and stated to be average samples of those now on the market gave, on careful measurement, the following figures for the voltage amplification of the stage when using the 1 : 1 transformer described and illustrated.

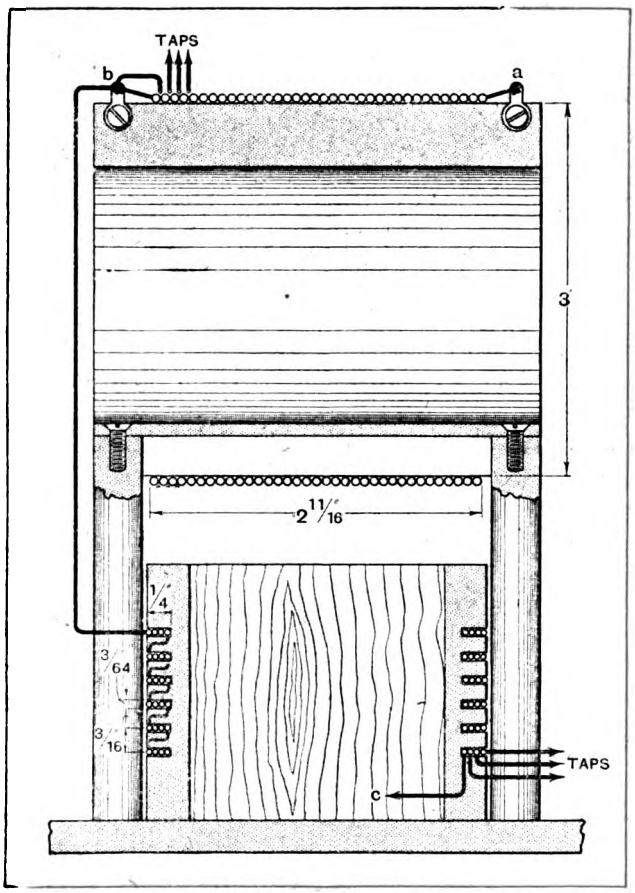

Fig. 5.—Winding data of grid coils wound on 9-ribbed 3" ebonite former. Medium-wave coil 70 turns 27/42 Litz. The four coupling turns shown tapped are of No. 32 D.S.C. Each slot of the long-wave former carries 35 turns of No. 32 D.S.C.

Wavelength.	Voltage Amplification.
250 metres	515 times
300 ,,	500 ,,
400 ,,	494 ,,
500 ,,	460 ,,
600 ,,	433 ,,

These figures are plotted as a curve in Fig. 4. They were taken under such conditions that reverse reaction due to the detector did not enter, so that in the receiver the amplification attained will be less. Since, however, these figures are chiefly of interest by virtue of the comparison they provide with other measurements of voltage amplification which have always been taken under the same conditions, the impression that they convey is strictly correct without taking this factor into consideration or modifying them in any way.

This high amplification is only attained when a determined attack on dielectric losses in the tuned circuit is made; for that reason the detector valve is decapped so that both the losses due to the valve-base and those due to the valve-holder are removed at one blow. If a valve is already to hand, the base may be loosened by a prolonged soaking in methylated spirit (about 48 hours is required). When the base is felt to be loose, the wires leading to grid, plate and cathode pins may be cut where they come through the base, and the tips of the heater-pins, to which their wires are soldered, may be cut off with cutting pliers. After straightening the wires, if it appears necessary to do so, the base may be gently removed. Connection is made to the five wires remaining by soldering, being careful that the hot iron does not touch the glass. The valve is supported in position, as shown in the photograph, by a metal clip lined with sponge rubber. This

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The Wireless World Record III.—

is bolted to the under side of the base, the clip being earthed to the metal screen through the bolt. The precaution of earthing all metal parts, even to the cases of the paper condensers, has been taken throughout the set; in nearly every case the fixing screws do this automatically, though a spot of solder has been added for luck at a few points.

With an amplification rising to over 500 times even the extremely effective screening of the AC/S valve is not sufficient to provide stability, and it has therefore been found necessary to introduce neutralisation. Owing to the fact that the scheme of neutralisation adopted, which has the advantage that it permits the use of standard components, does not provide a perfect bridge, it was found necessary to cut down all possible sources of instability to the minimum in order to ensure that a balance could be found that will hold over the whole tuning range. To ensure, further, that the setting of the neutralising condenser should not depend on the magnitude or position of the aerial, or on the length of the loud speaker leads, some care has been taken in preventing the emergence of high-frequency currents from the compartment containing the output valve. The precautions shown are completely effective in this direction.

The design of the tuned circuits for the upper wave-band is something of a compromise. If any attempt is made to reach the highest attainable amplification, the attenuation of side-bands by sharp tuning becomes great enough to spoil quality completely. If losses are introduced into the coils to remove this effect, selectivity becomes very poor before the side-bands are completely restored. The writers have not been able to hit upon any compromise between these three conflicting factors that improves in any respect on the long-wave transformers used in the "New Kilo-Mag Four," and both grid-coil and intervalve transformer are "lifted" bodily from that set without alteration save that the positioning of primary with respect to secondary in the transformer is altered to facilitate neutralising. Inspection of the full circuit diagram will reveal the fact that the switching from one wave-band to the other has been arranged in such a way that, while high-frequency losses may be introduced on the upper wave-band where they are welcomed rather than otherwise, on the lower band no additional losses are involved. The neutralising arrangements are such that no readjustment of the neutralising condenser is required on changing over from one wave-band to the other.

There are two volume-controls on the receiver; one deals with the received signals before they are rectified, and one after rectification. The former consists of a means of varying the voltage applied to the screening

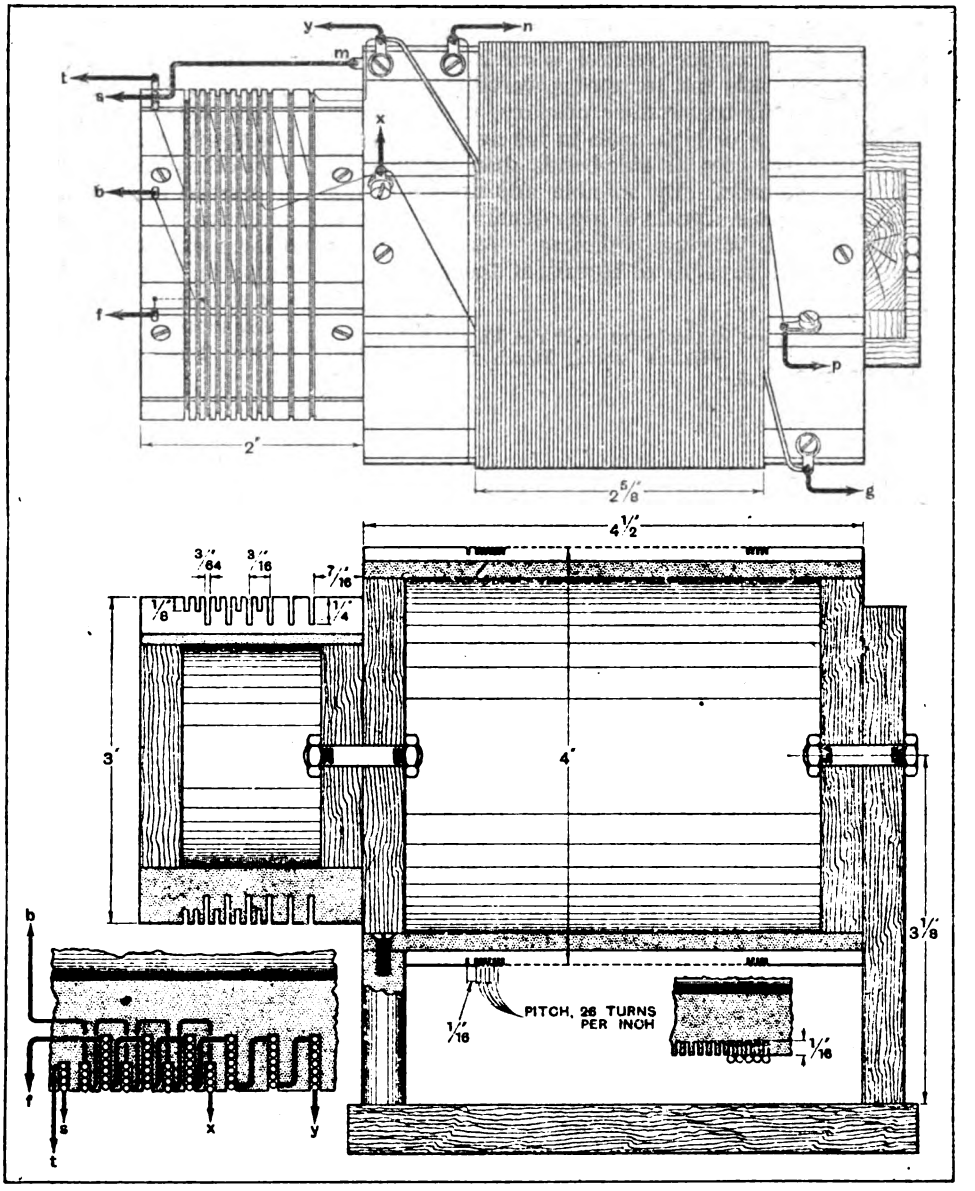

Fig. 6.—H.F. intervalve transformers. Medium-wave coils wound on 4", 8-ribbed former. Primary 68 turns No. 40 D.S.C.; secondary 68 turns 27 42 Litz; neutralising coil, 1 turn No. 40 D.S.C. Long-wave coils on 3", 9-ribbed ebonite former. Primary 4 sections each of 35 turns of No. 40 D.S.C. Secondary 35 turns No. 32 D.S.C. per slot. Neutralising coil 6 turns No. 32 D.S.C.

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The Wireless World Record III.—

grid of the high-frequency valve, whereby the amplification that it provides can be varied over very wide limits. In this way it is possible to ensure that the detector valve is working under the best possible conditions, at least whenever a station giving loud signals is being received.[3] As the detector, when working at its best, gives rather too large an output for the last valve to handle, a second volume control is advisable, and in this receiver it takes the form of a variable resistance shunted across the transformer primary, which results in a slight increase of high notes in the output, thereby counteracting any loss of side-bands that still remain in the tuned circuits. By suitable adjustment of the two volume controls, signals of high quality may be had from stations at varying distances. As an aid to estimation of the strength of signals at the detector, a milliammeter connected in its plate circuit is mounted on the panel of the set so that the deflection produced by tuning in a station may be read. It is not considered necessary to have a meter in the plate circuit of the output valve as an indicator of overloading because this can quite well be detected by ear.

It is the high efficiency of the indirectly heated valve that has made it possible to employ a transformer in its plate circuit in spite of the fact that it has an amplification factor of 35. As a result of its high amplification factor, the detector requires to operate it a smaller signal voltage than a corresponding battery-heated valve, and this, combined with the small output that it has to give to provide the last valve with all the signals it needs for operating the loud speaker at full strength, makes up to a large extent for the fact that the amplification of the single high-frequency stage does not quite come up to the standard of two ordinary stages, and renders not unreasonable the comparison of the present receiver with a 2-H.F. set of more usual design.

(*To be concluded.*)

[3]For a full discussion of this point see "The Valve as an Anode Bend Detector," *The Wireless World*, March 13th and 27th, 1929, pp. 279 and 326.

TRACING INSTABILITY.

Checking the Effect of Small Improvements.

IT is by no means uncommon for a newly built receiver embodying a high-frequency stage to insist upon oscillating whenever the two circuits are brought into tune with one another. If this instability is due to one single cause it is generally easy enough to trace, for one may try removing one possible cause after another until the culprit is found. It is in cases where the persistent oscillation is due to two or more separate causes, each contributing its share to the instability, that the task of eliminating the trouble and persuading the receiver to behave properly offers the greatest difficulty.

Let us suppose, to take a very simple example, that the instability is due to a failure of the screening boxes to make good contact, this bad contact existing in three separate places in the screening system. If the offending edges are held up into position one at a time there are always two edges left making the bad contact, and the improvement made by sealing up the one edge will not be enough to render the set stable. If each of the three edges are tried in turn it would be very easy, since oscillation cannot be stopped by holding up any of them, to conclude that the screening is guiltless, and that the unwanted feed-back must have some other source. Much time and ingenuity may then be spent in trying to stabilise the set without success.

For such a task as this we want to be able to detect the small lessening of the tendency to oscillate that is brought about by closing up the edges separately, so that the contribution of each to the total of feed-back may be estimated, or at least detected. One is then put on the right track at once.

The roughly quantitative estimation of the tendency to oscillate may be made by connecting a grid-leak in parallel with the first tuned circuit as a damping resistance, and finding by trial the lowest resistance that can be used without stabilising the set. With this in position and the receiver just, and only just oscillating when critically tuned, any lessening of feed-back brought about by closing temporarily one of our hypothetical bad joints can at once be detected by the cessation of oscillation. The alteration made then becomes permanent, and a new value of damping resistance, which will, of course, now be greater, is found, so that the original condition of critical instability is again attained. Closing up the second doubtful join once more stops oscillation, and once again the improvement is made permanent, so that a still larger resistance is needed across the first tuned circuit to prevent oscillation. With the third bad join closed it is found that the damping resistance can be removed entirely without incurring instability, and the problem is solved.

This mode of procedure is, of course, as applicable to instability arising from battery coupling or any other source, and provides a means of systematic attack on a difficulty which may well refuse to yield to less careful methods.—A. L. M. S.

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OCEAN STOCKBROKING SPEED RECORD.

ONLY 2½ minutes after a passenger on the White Star liner *Majestic* had handed in a request for a special stock quotation he received a reply from his brokers in New York. This is one instance of the efficiency of ocean stockbroking service on board the White Star liner *Majestic* on her latest voyage from New York to Southampton. Special Marconi equipment has been installed to provide the necessary facilities for this service without interfering with the normal wireless work of the ship.

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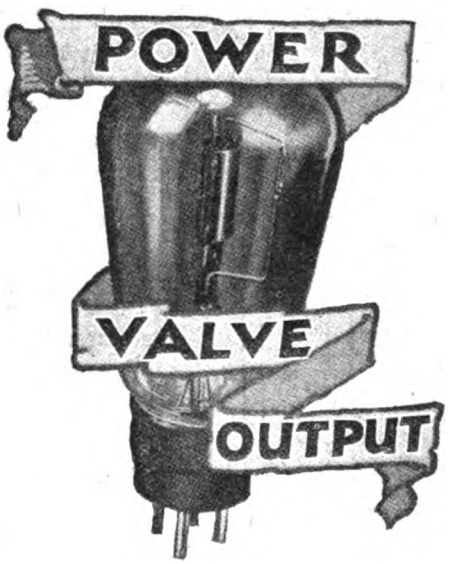

Comparative Figures for Undistorted A.C. Energy Obtainable from Typical Output Valves.

By F. E. HENDERSON, A.M.I.E.E.
(Of the G.E.C. Technical Staff).

WITH the increasing use of valves capable of giving greater and greater power output from a valve amplifier or radio receiver, the whole question of valve output is coming to be considered more and more by the amateur. There is, unfortunately, still a large section of the public who have to consider the most economical drain in current they can obtain from their source of anode supply, which is very often a dry battery, and the unfortunate valve manufacturer is still being asked in many quarters to provide a valve which will give a considerable undistorted output, with the condition laid down that it shall take little current from the H.T. battery.

As an intelligent interest in the proper use of the source of high-tension supply, in conjunction with a suitable valve, is undoubtedly growing, a few notes on this subject may be of use. The whole idea of what a power valve really is seems to be rapidly changing, when we recollect that only a few years ago the D.E.5 and its equivalent types were considered in this class and used for output purposes.

With the increasing use of loud speakers requiring more and more current to operate them, it was soon found that the normal anode current of the D.E.5 working under maximum conditions, namely, about 6 milliamps., was quite insufficient for the purpose. This led to the introduction of a modification in the D.E.5 type of valve by means of which a much larger current could be drawn from the anode battery, but, unfortunately, owing to the limited technique of valve design at that period, the modification of the valve to provide more anode current led also to a very big drop in the voltage magnification obtainable, and a much bigger input to the valve was now required. Such a valve as the D.E.5A class rapidly became very widely used by those anxious to obtain as large power output as was possible at that time without having recourse to excessively high anode voltages (see Fig. 1).

Simultaneously with the D.E.5A, the same change was occurring in valves designed for higher anode voltages, and we had the development of the L.S.5A, also capable of producing a much larger anode current than its prototype, the L.S.5, but which again requires a very big input.

In considering the choice of power valves there are two main considerations which must be borne in mind. The first is that of electrical efficiency, or the "mutual conductance"; and the second that of the maximum permissible power handling capacity. We have at present available power valves which definitely fall into one or other of these two classes. In the first class the aim is to provide the greatest possible output in anode current without the necessity for very large grid swing, or input volts. Such valves call for filaments of very high thermal efficiency and electrodes of close clearances, and when we look back over a few years it is remarkable what a tremendous increase in efficiency has occurred.

The P.625 class is typical of this new development, and shows a mutual conductance of 2.5 milliamps. per volt compared with a little less than 1.0 milliamp. per volt for the D.E.5 valve, while consuming the same filament energy. An interesting chart showing the improvement in overall efficiency of power valves in the 2-volt range is shown in Fig. 4, and is indicative of the development which has been taking place slowly in filament efficiency and electrode design.

It is, however, becoming more and more realised that the chief requirement of the output valve in an amplifier is its capability of producing a large undistorted A.C. power output and incidentally dealing with a considerable heat dissipation at the anode. If we could combine this property with that of high electrical efficiency, or mutual conductance, we should have an ideal state of affairs; but this is not always possible, as the requirements of high anode dissipation or high mutual conductance respectively call for entirely different features in valve design. The requirement of a power valve is its capability of producing a large A.C. component of the H.T. supply, and the response of the loud speaker is principally dependent upon the A.C. watts developed in its windings, which is roughly the product of the A.C. current and the voltage developed across the windings.

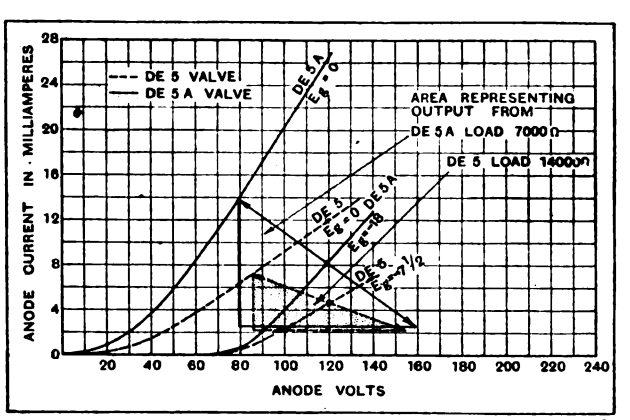

Fig. 1.—Diagram showing comparative outputs from D.E.5 and D.E.5A valves working at an anode voltage of 120.

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Power Valve Output.—

In considering the choice of a power output valve, therefore, it is very important to be able to have some idea of the value of the A.C. watts it is capable of developing in the loud speaker circuit. This circuit will be known as "the load."

To pass the large current called for it is evident that the filament of the valve must be capable of a very

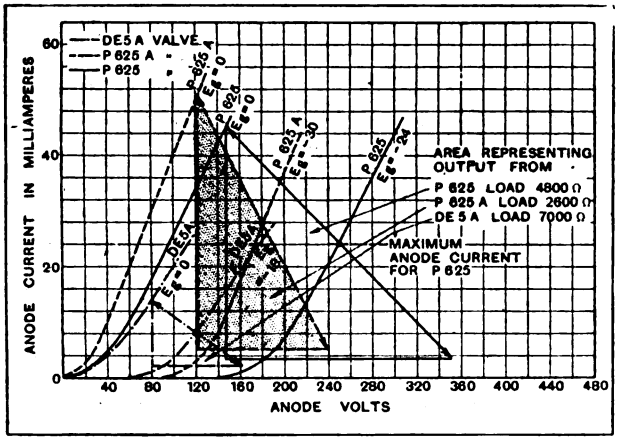

Fig. 2.—Showing the comparative outputs from D.E.5A, P.625A and P.625 valves with working anode voltages respectively of 120, 180 and 250.

liberal electron emission. Owing to the high velocity and large quantity of electrons which are continually being drawn to the anode, the latter will probably heat up considerably, and when a large power valve is working at its maximum capacity it is quite possible that the heat generated at the anode may be sufficient to cause it to become red hot. This circumstance calls for a special design of the anode if it is not to become excessively hot, with danger of melting, and efforts are also made in many valves to design the anode in such a way that its heat-dissipating properties are increased as much as possible.

With the heating of the anode comes also the danger of the liberation of occluded gas, and for this reason such valves often require special precautions to be taken in evacuation during manufacture and the provision of filaments which will not only stand up to extremely large and continuous electron emission but will be less likely to be permanently destroyed by the liberation of an exceedingly small quantity of gas in the valve during operation.

Determination of Output.

Valves such as the L.S.6A class are now coming into the market fitted with molybdenum anodes and very carefully designed to include all the above precautions, and the presence of such valves with a rated dissipation of 25 watts at the anode is an indication of the trend in this direction.

By simple application of Ohm's Law we can arrive at a very useful relation of the valve constants in conjunction with the A.C. power developed in the load.

Assuming the following symbols:

Amplification factor of valves = m.

Valve impedance or A.C. resistance = R_a.

Impedance of load at a given frequency = R_L.

Total grid swing in peak volts = E_g.

Total grid swing in R.M.S. volts = $\frac{E_g}{2\sqrt{2}}$.

we can arrive at the following:

The current flowing through the load

$$= \frac{\text{amplified voltage}}{\text{total resistance of output circuit}}$$

$$= \frac{mE_g}{2\sqrt{2}(R_L + R_a)}$$

Volts across load

$$= \text{current} \times \text{resistance}$$

$$= \frac{mE_g}{2\sqrt{2}(R_L + R_a)} \times R_L$$

The power developed in the load

$$= \text{current} \times \text{voltage}$$

$$= \frac{m^2E_g^2R_L}{(2\sqrt{2})^2\ (R_L + R_a)^2} = \frac{m^2Eg^2R_L}{8(R_L + R_a)^2}$$

It is usual to assume that with triode valves the best efficiency conditions are those when the impedance of the external load is twice that of the impedance, or internal resistance of the valve in series with this load. Under certain conditions this may be true, but it does not always follow, as is explained later.

From the above expression it will be seen that the useful power developed in the loud speaker or external load is directly proportional to the square of the valve amplification factor, and increases with decrease of valve impedance. It will thus be obvious why it is desirable

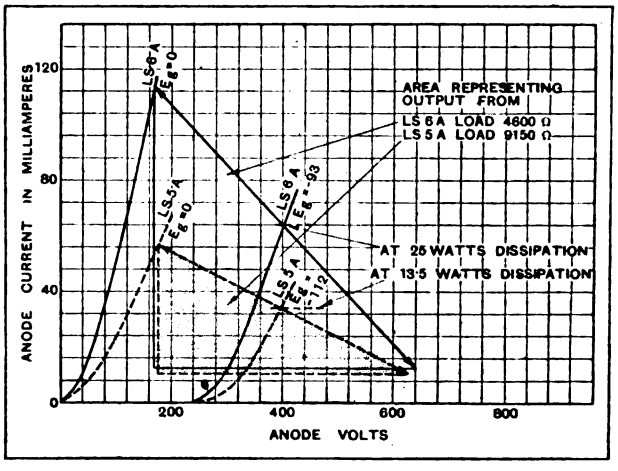

Fig. 3.—Comparative outputs from L.S.5A and L.S.6A valves at an anode voltage of 400.

to have a valve of high mutual conductance, or ratio $\frac{m}{R_a}$.

It will also be seen that the power is proportional to the square of the grid swing, and as this is a function of the anode voltage for a valve of given characteristics, it is thus desirable to use as high an anode voltage as is

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Power Valve Output.—

permitted by that class of valve if the maximum power output is to be obtained.

To arrive at a useful indication of the undistorted power output we can utilise the above expression in the following manner:—

Consulting the anode current - anode volt characteristic of the valve in question, we can determine the negative grid bias which will give the anode current for the anode voltage specified as the maximum permissible for that particular valve by the makers. Sometimes, instead of maximum anode current for a given maximum

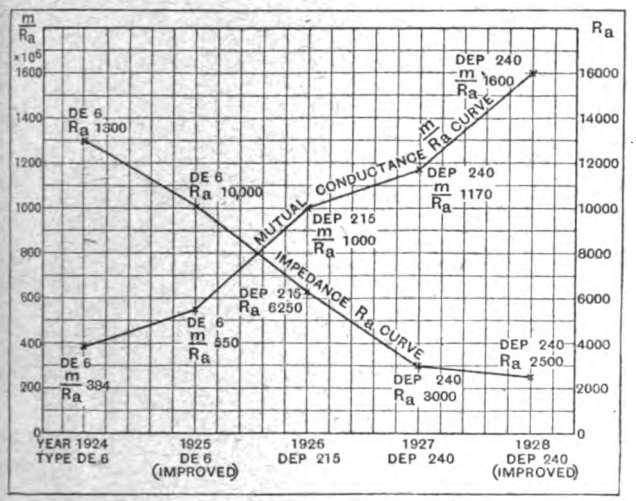

Fig. 4.—Improvement in two-volt power valve characteristics is here shown as a chart. The remarkable rise in mutual conductance is due to greater filament efficiency and attention to electrode design.

anode voltage, the maximum permissible anode dissipation in watts is specified. If this is so, the desired anode current can always be obtained by the expression:

$$\text{Anode current} = \frac{\text{watts dissipation}}{\text{anode volts}} \times 10^3 \text{ milliamperes.}$$

Given this fixed point on the curve as a centre, it is possible to draw a straight line to cut each grid voltage curve; this line should be extended in the upward direction as far as $E_g = 0$ if the valve is to receive full modulation—that is, maximum permissible grid swing. This is, of course, assuming that no grid current commences to flow until E_g becomes positive. For absolute distortionless output the swing of grid volts on the negative side of the bias point should be exactly equal to that on the positive side, and should give rise to exactly equal swings in anode current.

With very low impedance, low m valves, this is not always so until the slope of the line drawn becomes exceedingly flat, and even then anode distortion may be present. The slope of this line represents the impedance of the load (R_L), and this impedance should be chosen so that the valve is delivering the maximum power output with the minimum distortion allowable.

It is usually necessary to assume a small percentage of distortion; owing to the fact that opinions may vary as to the amount of distortion permissible, it is impossible to arrive at any hard-and-fast figure for the undistorted A.C. output for any valve. Such a figure must necessarily be based on an assumption which may vary in individual cases. With power valves, we cannot then assume the load impedance twice that of the valve impedance; with the minimum of anode distortion it will usually be much higher than this figure, and as we reduce the percentage of anode distortion the power output from the valve will gradually diminish.

Although it will now be appreciated from the above that actual figures to represent the undistorted output or A.C. power developed in the load cannot be taken as definite in the same way as can the figures representing the static characteristics of the valve, yet it may be useful for the purpose of comparison to see how certain valves compare with each other in respect of the output they can deliver.

The following table is therefore given, which is intended merely to serve as a basis of comparison between different classes of valve.

VALVES OPERATED AT MAXIMUM ANODE VOLTAGE.
(Figures for load impedances quoted are assumed for greatest *undistorted* output.)

Type of Valve.	Anode voltage.	Load impedance assumed. Ohms.	Undistorted A.C. power output.
D.E.P. 215	150	11,500	0.15 watts
D.E.P. 240	150	7,000	0.36 ,,
P. 425	150	5,000	0.26 ,,
P. 625A	180	2,600	0.90 ,,
P. 625	250	4,800	0.90 ,,
L.S. 5A	400	9,150	2.53 ,,
L.S. 6A	400	4,600	5.14 ,,

The expression arrived at above cannot be used for other than triode valves, that is, it would be quite unsuitable for estimating the power output from a pentode valve owing to the fact that for many reasons it is very undesirable, and indeed dangerous, for the load impedance to be twice that of the valve impedance if this is a pentode.

The whole subject of power output from pentode valves is one which requires special treatment, and cannot be dealt with here.

As the use of higher power valves is coming more and more to the fore, it is possible that some of the above remarks may be helpful to those who are considering the use of such valves for the first time, and wish to operate them intelligently.

BOOKS RECEIVED.

The New Company Law as it affects (*a*) Private Companies, (*b*) Public Companies, by H. W. Jordan. Showing the principal changes in law occasioned by the Companies Act, 1929, which comes into force on November 1st. Pp. 106+XIII. Published by Jordan and Sons, Ltd., London. Price 4s. post free, or, bound with copy of the Act, 9s. post free.

Some Observations of Short-period Radio Fading, by T. Parkinson (Research Paper No. 70). Pp. 19, with 17 diagrams. Published by the Bureau of Standards, Washington, D.C., U.S.A. Price 5 cents.

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Relation of Radio Wave Propagation to Disturbances in Terrestrial Magnetism, by I. J. Wymore (Research Paper No. 76). Pp. 11, with 6 diagrams. Published by the Bureau of Standards, Washington, D.C., U.S.A. Price 5 cents.

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NEW SCREEN-GRID VALVE.

The Mazda 215 S.G. Battery-heated Valve.

IN the course of compiling the test report concerning the new Mazda valves (now marketed by Ediswan) and to which inclusion was given in last week's issue, it was realised that the superiority of certain of the coming season's valves over their predecessors represented an important advancement. More than the customary examination has therefore been considered worth while in order that readers may the more appreciate the significance of the new data and what the improved characteristics will mean to them by way of giving better set performance. We refer in particular to the 215S.G.

External Appearance.

Outwardly the valve looks much like any other screen-grid valve, there being a terminal, connected to the plate of the valve, mounted on the top of the bulb on a small metal boss. The screening grid is connected to the base of the valve using the pin that in a triode is joined to the plate. Just above the pinch there is visible a screening disc which is set horizontally and extends right across the bulb. It bears on its edge a rim about three-quarters of an inch deep, parallel to the glass of the bulb and only just inside it. The disc, with its rim, carries on within the valve the metallic screening that must surround the tuned circuits in any receiver into which it is built. Except for a comprehensive anode surrounding everything little could be seen through the "gettering" of the electrodes.

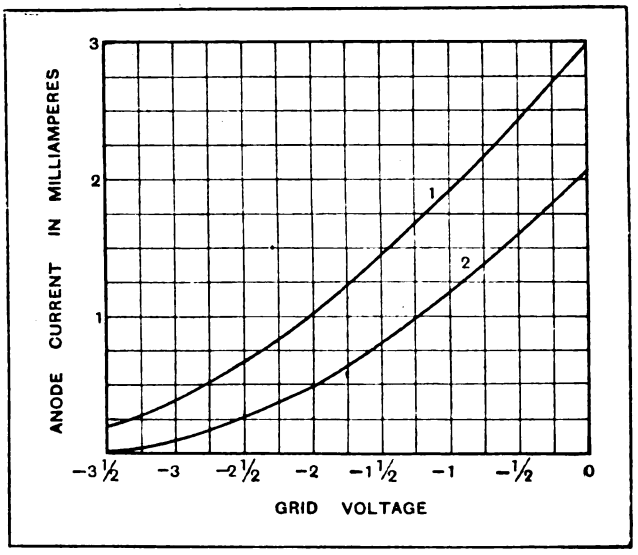

Fig. 1.—Anode current—grid volts characteristic curve 1 is taken with 150v. on the anode and 60v. on the screen, while in curve 2 the voltages are respectively 110 and 50.

The rated characteristics of the valve are as follows:—

Filament volts and current, 2.0 v. and 0.15 amps.
Amplification factor, 300.
A.C. resistance, 270,000 ohms.
Mutual conductance, 1.11 milliamps. per volt.

Static Characteristics.

Apart from the fact that the makers were unduly pessimistic as to the filament current consumed, which turned out to be only 0.125 ampere, or 20 per cent. better than the official figures, the rated characteristics were closely adhered to by the valve examined. Under normal operating conditions it was found that the mutual conductance of the valve was 1.1 milliamps. per volt, but that both amplification factor and A.C. resistance were a little higher than the rated values. There is no doubt that by a little juggling with the operating voltages the maker's figures could be reproduced exactly, for both amplification factor and A.C. resistance of a screen-grid valve vary over enormous ranges as the anode and screening-grid voltages are altered, though the mutual conductance remains nearly constant throughout. Some of the many possible curves are reproduced herewith, from which further details may be extracted by those who require them. The normal working plate-current is of the order of two to three milliamps. at 150 volts, while the screening-grid takes something less than 1 milliamp. at 60 volts. Taking into consideration the high amplification afforded by the valve, this consumption must be regarded as very moderate indeed.

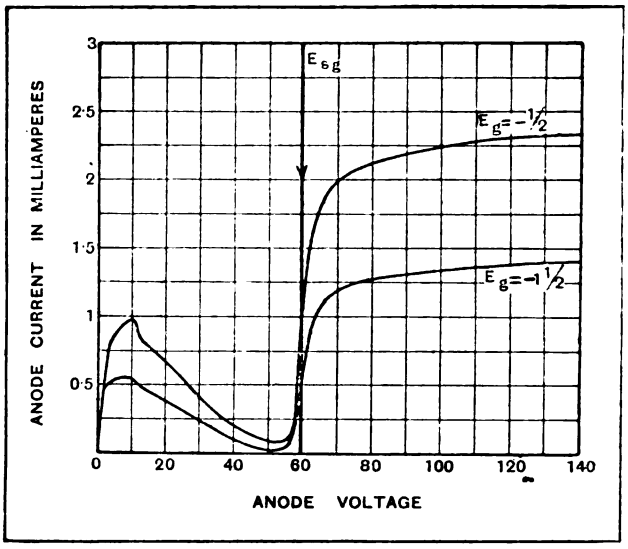

Fig. 2.—Anode volts—anode current curve. Screen volts=60.

With anode and screen-grid voltages set at their usual values it was found that grid-current started at −0.1 volt, so that it is essential to use grid-bias with the valve, though a very low value of bias will suffice.

Amplification Attained.

Although the actual amplification attained at high-frequency depends very much more on the tuned circuits in use than on the valve itself, it was, nevertheless,

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New Screen-grid Valve.—

thought worth while to make a few measurements to indicate the order of amplification to be anticipated with tuned circuits of various types. The circuit employed for the purpose is shown in Fig. 3, particulars of the chief components used being given below the diagram. All measurements were made at approximately 300 metres, and the anode voltage used was 150 throughout, the screen-grid voltage being adjusted for maximum amplification with each tuned circuit. Throughout the series it was found necessary to keep the screen-grid at a voltage in the immediate neighbourhood of 60 for best results.

(1) Coil L (Fig. 3) of 68 turns of 27/42 Litz on 4in. ribbed ebonite former; detector (voltmeter) valve shunted across the tuned circuit decapped to minimise dielectric losses. Amplification, 188 times.

(2) Coil of 80 turns of 27/42 Litz on 3in. ribbed ebonite former; detector valve still decapped. Amplification, 161 times.

(3) Coil as in (2), but valve-holder and valve-base shunted across tuned circuit to represent, with the decapped valve, a valve with cap and holder, as usually employed. Amplification, 131 times.

(4) Multi-layer coil (Gambrell B), with valve-holder and base in position as before. Amplification, 59 times.

For all the measurements detailed above a grid-bias of $-1\frac{1}{2}$ volts was in use. With an amplification of the order of those found the valve has to deal with a grid-swing of less than a fifth of a volt in the most unfavourable case, so that it is quite unnecessary to bias it heavily enough to permit it to accept a swing of three volts. As an indication of the increase in amplification that can

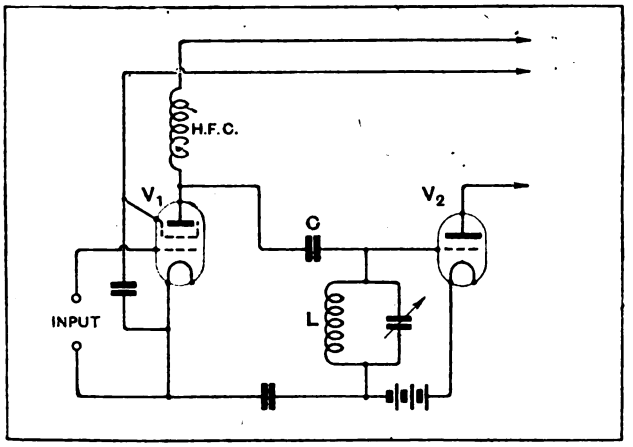

Fig. 3.—Circuit used in measuring amplification at 300 metres. V_1, Mazda 215 S.G. valve under test. V_2, Decapped valve in Moullin voltmeter measuring voltage across tuned circuit. H.F.C., Lewcos High-frequency choke. C, 0·001 mfd. L, Tuning coils—see text.

be obtained by cutting the bias down to the minimum figure that is still enough to prevent the flow of grid-current, the measurement of amplification with coil (1) was repeated while using a bias of only -0.25 volt. The figure attained was 215 times in place of the 188 times originally recorded, an increase of nearly fifteen per cent.

A stage amplification of 215 times for this battery-fed S.G. valve is the maximum that can be obtained in a tuned anode circuit in which choke-feed is employed, and can only be had by those who are willing to go to the limit in the elimination of dielectric losses both in the tuned circuits themselves and in the components connected to them. If the tuned circuit following the valve feeds a detector valve normally capped and inserted in a standard type of holder the limit is set at about the figure of 131 already given. It is further to be noticed that it would be profitable to employ a transformer in place of tuned anode when using a tuned circuit of the very high dynamic resistance that is attained when dielectric losses are eliminated in the manner suggested; a suitable ratio would be about 1:1.25, obtained by fitting a primary of about 54 turns to the coil described under (1) above. With this transformer an amplification of about 240 times might confidently be expected.

When the tuned circuits have higher losses, whether these arise from the coil itself or from the unsuitable nature of the dielectrics connected in parallel with it, the dynamic resistance will be too low to make the substitution of transformer-coupling for plain tuned anode a paying proposition, and no appreciable increase over the figure of 131 can be anticipated. It will be noticed that this is barely more than half the amplification that can be attained when dielectric losses are reduced to a minimum.

Base Losses.

It is unquestionable that any valve which is intended for use with high-frequency circuits should not introduce any unnecessary damping into them, so that it was thought worth while to make a cursory investigation of the losses introduced into a tuned circuit by connecting across it an unlighted 215 S.G. As it is found that dielectric losses, when expressed as a shunt conductance, are nearly independent of wavelength, the losses were measured at one wavelength only, 250 metres being chosen for the purpose.

It was found that the unlighted 215 S.G. introduced into a tuned circuit losses which could be matched by replacing the valve by a non-inductive grid leak of 590,000 ohms. Where thoroughly bad tuned circuits are in use this loss does not, perhaps, matter; but in any receiver in which attempt has been made to wind coils of low high-frequency resistance in the endeavour to attain a high standard of sensitivity and selectivity the damping effect of the valve-base will be very appreciable indeed. The table that follows shows the result on the dynamic resistance of a tuned circuit of connecting the valve in parallel with it. The effect of the valve-holder is not included in these figures.

Dynamic Resistance of Tuned Circuit alone. (ohms.)	Dynamic Resistance with Valve in parallel. (ohms.)
450,000	255,000
350,000	219,000
280,000	190,000
180,000	138,000
100,000	85,000

It is to be noticed that with a tuned circuit of 100,000 ohms dynamic resistance the connection of the valve only reduces the value by some 15 per cent., while

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New Screen-grid Valve.—

the dynamic resistance of an ultra-low-loss circuit is reduced to little more than half its proper value.

On removing the base of the valve and repeating the measurement of losses it was found that the base had been contributing nearly ninety per cent. of the losses, the valve proper, without its cap, being equivalent in its damping effect on a tuned circuit to a resistance of a little under five megohms. It is perhaps permissible to assume that when the valve is in full production more care will be taken in choosing for the base a material of good dielectric properties, and that the unusually high losses introduced by the base of the sample examined is not to be taken as typical.

Internal Screening.

The residual capacity between the grid and plate of the 215S.G. is given as 0.005 micromicrofarad, which implies that the screening is considerably more thorough than is usual in screen-grid valves.[1] No attempt was made to measure this capacity directly, but, instead, a test of stability was made by connecting in plate and grid circuits the lowest-loss tuned circuits that were available. At no point of the tuning range, which extended down to 250 metres, was the combination unstable. Recourse to calculation showed that with the tuned circuits used, after making due allowance for the damping of the input circuit by valve-base losses, a residual capacity of about 0.006 micromicrofarad would be required to cause spontaneous oscillation. It follows, therefore, that the internal screening of the valve is of a very high order indeed, and it may safely be used, so long as it is not decapped, with coils of the highest efficiency.

[1] See "The Modern H.F. Valve," *The Wireless World*, July 24th and 31st, 1929.

THE NEW BERNE LISTS.

We have received from the International Bureau of the Telegraph Union a complete set of the five volumes which now constitute the "Berne List." We have already noticed Part I (Fixed and Land Stations) in our issue of June 12th, and in subsequent numbers.

Part II is the list of the stations performing special services, and is divided into six sub-sections (A) Direction-finding, (B) Beacons, (C) Time-signals, (D) Meteorological, (E) Notices to Mariners, (F) Press Messages, (G) Medical Advice, Calibrated Waves, etc. The stations are grouped under their respective countries. We think this section could be improved and made easier for quick reference if the titles of the sub-headings were printed at the head of each page, as it is difficult to distinguish at a glance subsection (D) from sub-section (E). This part comprises 175 pages.

Part III is a large volume of 876 pages, giving a list of all ship stations. These are conveniently arranged in alphabetical order, and the particulars include the call-signs, country, type of installation, wavelengths, normal power and administration or company responsible for the operation of the wireless sets and the rendering of the necessary accounts.

Part IV is a list of aircraft stations, arranged in order of their call-signs, though we note that the five Swiss aeroplanes which head the list have not adopted the group of five letters specified in the Washington Convention. The other particulars given include the nationality, type of installation, wavelengths, nature of service, customary route or home air port, and mark and type of aeroplane or airship. This list is 46 pages in length.

Part V comprises the broadcasting stations of the world, both those operated by public corporations such as the B.B.C., and the Radio Broadcasting Co., of New Zealand, and those owned by private companies. We were somewhat disappointed, however, in discovering that, with a very few exceptions, the short-wave stations are not included and hope that these will follow in a later supplement. The stations are arranged under their respective countries, and the particulars include the call-signs, geographical positions, frequency and wavelengths, normal power, and name of administration or company operating the respective stations.

The prices of the respective parts, including their monthly supplements, are: Part I, fcs. (Swiss) 7.50; Part II, fcs. 7.50; Part III, fcs 12.00; Part IV, fcs. 4.50; Part V, fcs 4.50; and they may be obtained from the Bureau International de l'Union Télégraphique, Berne, Switzerland. The corresponding alphabetical list of call-signs, which will comprise those of all stations in the five lists, is now in preparation and will shortly be issued, price fcs. 6.40.

The subdivision of the list into five parts is undoubtedly a great convenience, as the previous editions containing all stations had become unwieldy. We would like to suggest the publication of a further list comprising only stations transmitting on wavelengths below 100 metres, but possibly the authorities do not consider the expense of compiling such a list would be justified by the demand.

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TRANSMITTERS' NOTES.

General Note.

We are asked to state that the German amateur D4QE is anxious to get into touch with English stations and to receive reports from this country. He is generally working from 22.00 B.S.T. onwards on telephony and transmits on about 42 metres. Reports may be sent *via* Mr. A. Brown, 7, Stanley Road, Broughton Park Manchester.

NEW CALL-SIGNS AND STATIONS IDENTIFIED

G 5QY H. C. D. Hornsby, The Quarry, Cramlington, Northumberland.
G 6GD S. H. Goodwin, 8, New Barns Ave., Commonside East, Mitcham, Surrey. (Change of address.)
G 6WH G. H. Wheatley, 5, Eliot Bank, Forest Hill, S.E.23. (Change of address).

RUSSIAN CALL-SIGNS

We are indebted to Mr. A. Lambourne, 43, Bramshaw Road, Norcot, Reading, for the following list of QRA's in the 2nd Russian District:—

EU 2DA (ex 79RB), M. Ryabov, Nijni Novgorod.
EU 2DB (ex 80RB), M. Pavlov, Moscow.
EU 2DC (ex 81RB), M. Petropavlovskiy, Moscow.
EU 2DD (ex 82RB), M. Homutov, Moscow.
EU 2DE (ex 88RB), M. Zorin, Kimrer.
EU 2DF (ex 93RB), M. Gauhman, Rubinsk.
EU 2DG (ex 97RB), M. Alekseevskiy, Voronej.
EU 2DH (ex 98RB), M. Roshchupkin, Voronej.
EU 2DI (ex 99RB), M. Saltakov, Tambov.
EU 2DJ (ex 20RW), M. Starikov, Moscow.
EU 2DK (ex 21RW), M. Mehov, Moscow.
EU 2DL (ex 22RW), M. Shishkov, Moscow.
EU 2DM (ex 23RW), M. Rjanicin, Moscow.
EU 2DN (ex 24RW), M. Shsenko, Moscow.
EU 2DO (ex 25RW), M. Volodin, Moscow.
EU 2DP (ex 54RW), M. Fivaksel, Nijni Novgorod.
EU 2DQ (ex 62RW), M. Raspletin, Rubinsk.
EU 2DR (ex 63RW), M. Pereverzev, Rubinsk.
EU 2DS (ex 66RW), M. Katkov, Tver.
EU 2DT (ex 67RW), M. Lobanov, Rastvapino.
EU 2DU (ex 68RW), M. Evseev, Nijni Novgorod.
EU 2DV (ex 42RB), M. London, Moscow.
EU 2DW (ex 60RB), M. Osipov, Moscow.
EU 2DX M. Belov, Moscow.
EU 2DY M. Shenner, Moscow.
EU 2DZ M. Ivanov, Yaroslavl.
EU 2EA M. Kurlev, Yaroslavl.
EU 2EB M. Shestakov, Tula.
EU 2EC M. Surnikov, V. Volochek.
EU 2ED M. Shatalov, Tula.
EU 2EE M. Pastukov, Moscow.
EU 2EF M. Uspenskiy, Moscow.
EU 2EG M. Nikanorov, Moscow.
EU 2EH M. Kucherenko Orel.
EU 2EI M. Shuhman, Orel.
EU 2EJ M. Partenov, Orel.
EU 2EK M. Pantelevmonov, Voronej.
EU 2EL M. Romakin, Yaroslavl.
EU 2EM M. Kojevnikov, Yaroslavl.
EU 2EN M. Kojinkov, Khoroshevo, Moskgub.
EU 2EO M. Nazarov, Tula.
EU 2EP M. Kurabdev, Tula.
EU 2EQ M. Krenkel, Moscow.
EU 2ER M. Fedoscev, Moscow.
EU 2ES M. Sorokov, Moscow.
EU 2ET M. Shevdov, Moscow.
EU 2EU M. Kojevnikov, Moscow.
EU 2EV M. Kalinin, Voronej.
EU 2EW M. Bavdin, Moscow.
EU 2EX M. Kruglov, Der. N. Ersh. Yaroslavsk Gub.
EU 2EY M. Bryanskiy, Tambov.
EU 2EZ M. Vinogradov, Serpukov.
EU FA M. Chmil, Kaluga.
EU FB M. Peychev, Moscow.

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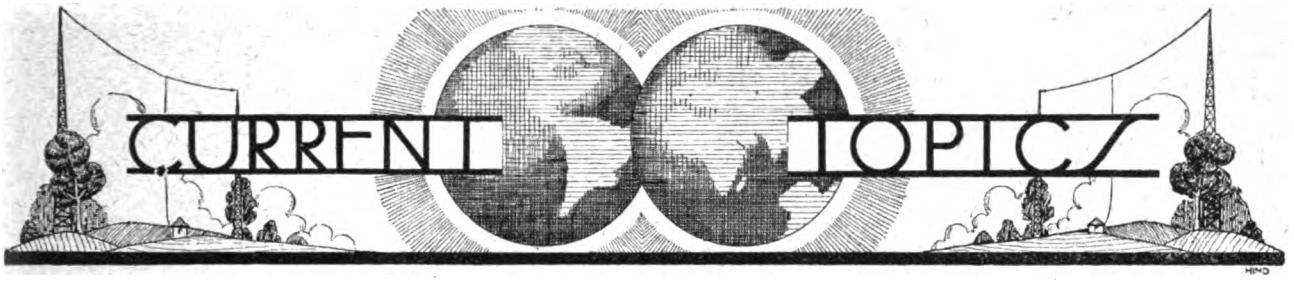

Events of the Week in Brief Review.

THE SEASON RE-OPENS.

A wave of wireless enthusiasm is reported to be sweeping over the Doncaster district. What Doncaster thinks to-day, the world thinks to-morrow.

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"THE FRIENDS OF WIRELESS."

An annual prize of a minimum value of £65 has been founded by the French organisation, "Les Amis de la T.S.F.," for the best theoretical or practical book dealing with wireless.

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PARIS INTERNATIONAL WIRELESS SHOW.

The first International Wireless Show to be held in Paris opens on Friday, September 27th, and will run for a fortnight. During most of this period the International Automobile Show will also be holding sway in Paris, and it is hoped that this event will bring foreign visitors to the wireless show.

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NO SECOND-HAND GEAR FOR STRASSBURG.

The report that Radio-Paris will shortly close down pending the installation of more powerful equipment has given birth to a further rumour that the old equipment will be reincorporated in the new Strassburg station. This suggestion is indignantly denied by local journals, who doubt the veracity of the original report concerning Radio-Paris, contending that the rejuvenation of this station has been "in the air" since 1926, and still shows little sign of fulfilment.

oooo

COMPROMISE IN CANADIAN BROADCASTING?

A combination of British and American broadcasting methods will be the probable recommendation of the Royal Commission appointed by the Canadian Government last year to enquire into the ways and means of re-establishing Canadian broadcasting on a sound basis.

It is believed that the Commission favours the formation of a central authority not unlike the B.B.C., but giving greater individual freedom to stations in view of the wide area to be covered. It is also probable that the Commission will admit the principle of "sponsored" programmes, so that advertisers will augment the income received from listeners' licences.

oooo

THE NEW LARCENY.

A street in Utrecht has been the scene of a new form of radio robbery, according to the French journal *Fantasio*. A resident who possessed a wireless set but no aerial recently made a secret connection to his neighbour's antenna, thereafter surprising his friends with the range and excellence of reception.

The owner of the aerial has intimated his intention of taking action in court, but his case is not regarded very optimistically by his legal advisers.

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TELEPHONING TO MOOSE JAW.

On Sunday last, September 1st, the Transatlantic telephone service was extended in Canada to Moose Jaw and Saskatoon, in the province of Saskatchewan. The service was extended to include the Isle of Man, Belfast, and Dublin on August 26th.

THE RUNNING COMMENTATOR. Mr. Floyd Gibbons, with the portable short-wave transmitter through which he was able to describe the arrival of the Graf Zeppelin at Lakehurst on Thursday last after its world flight. The account was broadcast by W2XAD and relayed by B.B.C. stations.

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I.E.E. WIRELESS SECTION.

The Institution of Electrical Engineers announces that as no nominations have been received from the general body of members of the Wireless Section to fill the vacancies which will occur on the Section Committee on September 30th next those members nominated by the committee are elected. The chairman of the committee for 1929-1930 will be Captain C. E. Kennedy-Purvis, R.N.

oooo

CANADA GETTING BUSY.

According to a preliminary statement issued by the Dominion Bureau of Statistics at Ottawa, the production of complete radio sets, parts, and batteries in Canada during 1928 reached a value of $12,768,024, or 45 per cent. above the total of $8,789,171 reported for 1927.

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WHERE ONTARIO WINS.

Ontario leads the other Canadian provinces in the number of wireless receiving licences issued. During the fiscal year ended March 31st, 1929, Ontario headed the list with 296,756, Quebec being second with 49,812. In the north-west territories 111 persons took out licences.

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"KONEL."

Many uses are predicted for a new metal known as "Konel" which has been developed by the Westinghouse Electric and Manufacturing Company of America. Originally prepared as a substitute for platinum in the manufacture of filaments for wireless valves, the new metal has been found to be harder to forge than steel and to be very tough at high temperatures.

The Westinghouse Company states that as a substitute for platinum, Konel is already saving £50,000 monthly in the manufacture of wireless valves, and that the life of a Konel filament is approximately ten times longer than that of others. Valves with the new filaments are operated 175 degrees cooler than those with platinum filament, but it is stated that the emission remains the same.

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PRIZES FOR SET BUILDERS.

Cash prizes totalling about £200 are to be awarded to successful wireless set builders in connection with the Wireless Exhibition to be held in Manchester in October under the auspices of the *Manchester Evening Chronicle*.

A feature of the show will be demonstrations on amateur-constructed sets. Four classes of competition will be open to amateur craftsmen, as follows: Class I, Three-stage Receiver for Distance Reception; Class II, Three-stage Receiver for Quality Reproduction: Class III, Three-stage Daventry and Local Station Receiver, and Class IV, High-frequency

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Unit. The value of the prizes will range from twenty-five guineas to two guineas. A schedule and entry form is being prepared, and intending competitors should make early application to the Wireless Editor, *Manchester Evening Chronicle*, Withy Grove, Manchester.

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LECTURES ON A.C.

Lectures on alternating currents and electrical oscillations, with their application to wireless telegraphy and telephony, are included in the winter syllabus of the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C. Full particulars are available on application to the principal.

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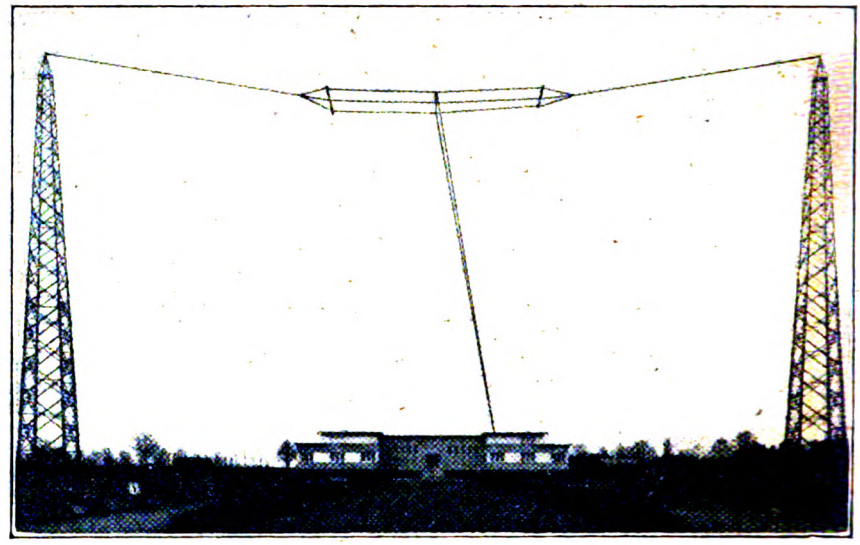
WEATHER CHARTS BY FULTOGRAPH.

The Meteorological Office of the Air Ministry issues a request to owners of picture receiving sets for copies of any weather charts they may have received since June 18th, when the experimental transmission of weather maps from Daventry 5XX by Fultograph process was begun. The experiment is now about to terminate.

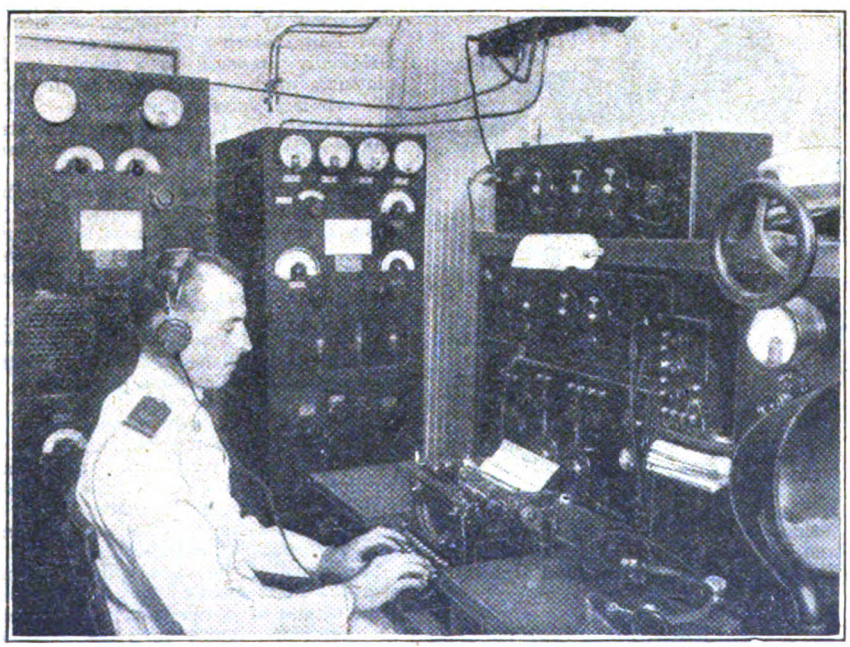
The results which have been so far received indicate that these maps can be transmitted and received satisfactorily under normal conditions at least as far north as Glasgow and Dundee.

During the course of the transmissions opportunity was taken, through the courtesy of Wireless Pictures, Ltd. (in co-operation with whom the charts were being issued, to transmit a written inference of the weather to be anticipated from the chart which was simultaneously transmitted. The reception of this written inference was just as satisfactory as that of the chart.



A POPULAR DEUTSCHLANDER. A new view of the Cologne broadcasting station which relays Langenburg and can be heard nightly on 227 metres. The power is 4 kilowatts.

Copies of the maps received at the following places, Cardington, Worthy Down, Upper Heyford, Ramsgate, Streatley-on-Thames, Guernsey, Ashington, Taunton, Bradford, Glasgow, and Leuchars—have already been compared with the original charts and found to be normally satisfactory. Copies of charts received at places other than the above would be welcomed by the Director, Meteorological Office, Air Ministry, London, W.C.2. After examination they would, if desired, be returned to the senders.



STOCKBROKING ON THE ATLANTIC. British, French and American liners are all successfully conducting stock exchange services at sea. This photograph, taken on the U.S. liner Leviathan, shows the second operator receiving New York stock quotations on a specially installed short-wave set operating on wavelengths between 15 and 120 metres.

EIFFEL TOWER AT BAY.

In view of continued representations for the suppression of the Eiffel Tower wireless station, the staff have produced a spirited reply in the form of a record of the station's daily output. Transmissions go out for nineteen hours each day between 1 a.m. and midnight and comprise 51 separate features, including concerts, weather forecasts, meteorological information for farmers, "chats" with ships at sea and aeroplanes in flight, traffic messages to North Africa, and Stock Exchange quotations.

Five separate wavelengths are employed, viz., 7,200 metres, 2,650 and 1,470 metres, and 73.50 and 32.50 metres.

In the circumstances the idea of the suppression of FL is regarded as "grotesque and ridiculous."

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RECORD PUBLIC ADDRESS SYSTEM.

The B.B.C. arrangements for broadcasting a running commentary on the Schneider Trophy Race in the Solent on September 7th next have already been described, but most listeners will also be interested in the plans made for what will undoubtedly be the biggest public address system ever employed. Over two hundred Marconiphone loud speakers will be distributed at nineteen centres along both shores of the Solent and on liners in the roadstead, and through these it is expected that nearly a million spectators will be able to hear the B.B.C. running commentary, which will be picked up on standard receiving sets and raised to enormous volume by power amplifiers.

To supply power to the loud speakers no fewer than 756 valves will be used, 694 of these being of the super-power type. The supply of high-tension current will require 392 Exide 30-volt H.T. batteries and 168 large capacity 60-volt H.T. batteries. Over fifteen miles of wire will be needed to connect the various batteries, amplifiers, and loud speakers.

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A Review of Manufacturers' Recent Products.

"TEKADE" TRICKLE CHARGER.

The "Tekade" L.T. battery charger sent in for test is intended for trickle charging 2- and 4-volt accumulators from the domestic alternating current mains. The model illustrated is for use on 200- to 240-volt A.C. mains, but there are other

"Tekade" trickle charger for use on A.C. mains. This model charges 2- and 4-volt batteries.

types available for 100- to 125-volt supplies. Tests were made on a 240-volt 50-cycle supply, the charging current being 0.32 amp. for a 2-volt cell and 0.3 amp. for a 4-volt battery. It was noticed that after the charger had been in use for about half an hour the current fell to 0.25 amp. and 0.27 amp. for the 2- and 4-volt batteries respectively. This is probably due to some slight change in the resistance of the rectifier, since after this initial fall the current was maintained at a steady level.

The charger consists of a small transformer and a half-wave rectifier of the "dry" type which the makers state will give a charging rate of 0.25 amp. This claim is substantiated by our tests. There was no trace of overheating, the rise in temperature being very slight after a lengthy run. The device is perfectly silent when in use.

The unit is enclosed in a metal case measuring 6in. × 3¼ × 2¼in. A long silk-covered twin cable terminating in an adaptor is provided for attachment to the lamp holder and two leads with plugs and spade terminals are supplied for connecting the accumulator.

Supplies are available from Dr. Nesper, Ltd., Colindale Avenue, Hendon, London, N.W.9.; the price of the 2- and 4-volt model being 29s. 6d. A unit for charging 2-, 4- and 6-volt batteries is available also; the price of this model is 38s. 6d.

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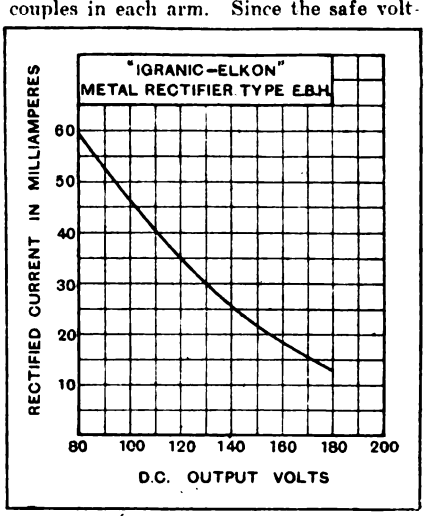
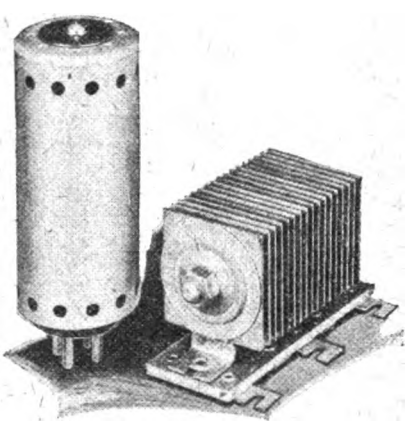
IGRANIC-ELKON METAL RECTIFIERS.

A wide range of these rectifiers are available, including some small units for use in L.T. battery chargers, and a high voltage rectifier for incorporation in H.T. battery eliminators. Two samples were submitted for test, a model M16, rated to give a D.C. charging current of 3 amps, and a model E.B.H., which is stated to give an output of 60 mA.—rectified current—at a potential suitable for most broadcast receivers. Full-wave rectification is allowed for in both cases.

Model M 16 comprises 16 couples arranged as a bridge type rectifier with 4 couples in each arm. Since the safe voltage difference across each couple is of the order of 3.6 volts, the transformer should not give a voltage in excess of 15 (R.M.S.). A practical test showed that the unit will deliver 3 amperes of rectified current to a 6-volt accumulator without need of an external resistance, but a current-limiting resistance must be used with 2- and 4-volt



Voltage regulation on load; the secondary of the transformer gave 200 + 200 volts R.M.S.



Igranic-Elkon "dry" rectifiers. Model E.B.H. is fitted with four base pins.

cells. The amount of reversed current is surprisingly small, measurements showing this to be less than 2 per cent. of the forward current under normal working conditions.

The E.B.H. unit is for use in place of a thermionic type rectifier in H.T. battery eliminators, and is accordingly fitted with a base cap provided with pins for insertion in a valve holder. The sample submitted for test was fitted with pins to fit the American valve holders, but an adaptor can be obtained from the suppliers for use in British type valve holders. This unit will withstand a voltage difference of the order of 300 across each half of the rectifier—although being a full-wave rectifier it is not arranged on the bridge principle. The transformer used during test gave 200 volts R.M.S. either side of the centre tap only, but measurements were made with this for the purpose of taking the characteristics of the unit under normal working conditions. The output voltage at different current loads is given

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on the graph; the unit being followed by the usual network of smoothing circuits. The rise in temperature during use is comparable with that of a heavy duty thermionic type of rectifier.

The suppliers are the Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4, and prices have been fixed as follows: Model M 16, 29s. and Model E.B.H., 37s. 6d.

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B.T.H. PICK-UP AND TONE ARM.

The B.T.H. pick-up is notable for generous cross-section of its permanent magnet and the lightness of the reed. The latter is only $\frac{7}{16}$in. in length and is mounted midway between the pole pieces of the permanent magnet, thus producing differential variations of the flux surrounding the pick-up coil. The latter is mounted concentrically with the axis of the reed. Damping is provided by rubber pads both at the pivot and the extremity of the reed. Nevertheless the movement is not unduly restricted, and record wear is absolutely negligible.

As a consequence of the light damping and freedom of movement the natural resonance of the reed is rather prominent. By careful design, however, the makers have succeeded in raising this to 3,400 cycles, which happens to be within a semi-tone of the top note of the piano. For all practical purposes this may be taken as the upper limit of the fundamentals used in music, so that, as far as fundamental notes are concerned, the pick-up may be regarded as having a rising characteristic which will tend to correct deficiencies in the average amplifier and loud speaker. As a result the reproduction is unusually brilliant by comparison with the average pick-up.

There are no prominent resonances in

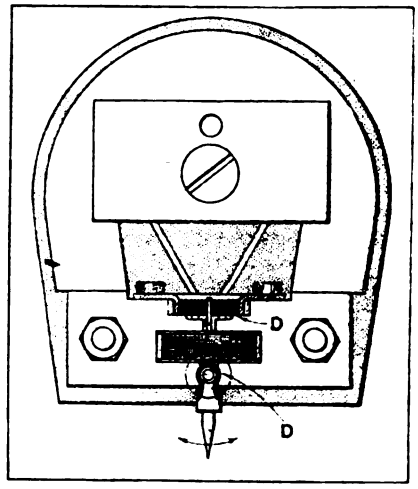
B.T.H. pick-up and tone arm.

the middle and lower registers, and the undulations in the curve would not be detected even by a trained ear. Below 100 cycles the curve continues to rise, and thus corrects for the restriction in amplitude of the low notes in the average record.

The general form of the curve is independent of the type of needle used, but a thick and heavy needle tends to reduce the natural resonance by 400 or 500 cycles, thus bringing it into the range of frequencies in common use. For best results the H.M.V "Half Tone" or similar type of needle should be used.

The pick up is fitted to the tone arm by means of a neat two-contact plug and socket through which electrical connection is made to a twin flexible lead passing through the tone-arm pedestal. The tone arm is spring-loaded to relieve some of the weight of the pick-up, and friction is reduced to a minimum by the use of a ball-bearing swivel. The movement of the arm is restricted by a neatly arranged stop incorporated in the pedestal.

Without resorting to any form of link motion it has been found possible, by bending the tone arm and making it adjustable for length, to reduce the needle track error to within 3 per cent.



Constructional details of B.T.H. pick-up.

Full instructions are provided for aligning the tone arm, and the complete outfit, including a spring clip for the tone-arm, is £2 5s.

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BELLING-LEE WANDER PLUGS.

It is regretted that the illustration of this new plug, given on page 112 in our issue of July 31st last, does not show clearly the nature of the prongs fitted. As mentioned in the text, they are not split pins, but assembled from two pieces of hard drawn "D" section brass wire.

This opportunity will be taken to correct an error in the price of these. They are now marketed at 3½d. each.

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PRICE CORRECTIONS.

With reference to the Watmel fixed condensers reviewed on page 131 in our issue of August 7th last the prices of these should read as follows:—Values of from 0.00004 to 0.0009 mfd. 1s. 3d. each with grid-leak clips, and 1s. each plain. Other sizes cost 1s. 6d. each from 0.001 mfd. to 0.004 mfd., and 2s. 6d. each for 0.004 mfd. to 0.01 mfd.

The Loewe resistances mentioned on page 96 in our July 31st issue are now sold at 1s. 6d. each and not 2s. 6d. as stated.

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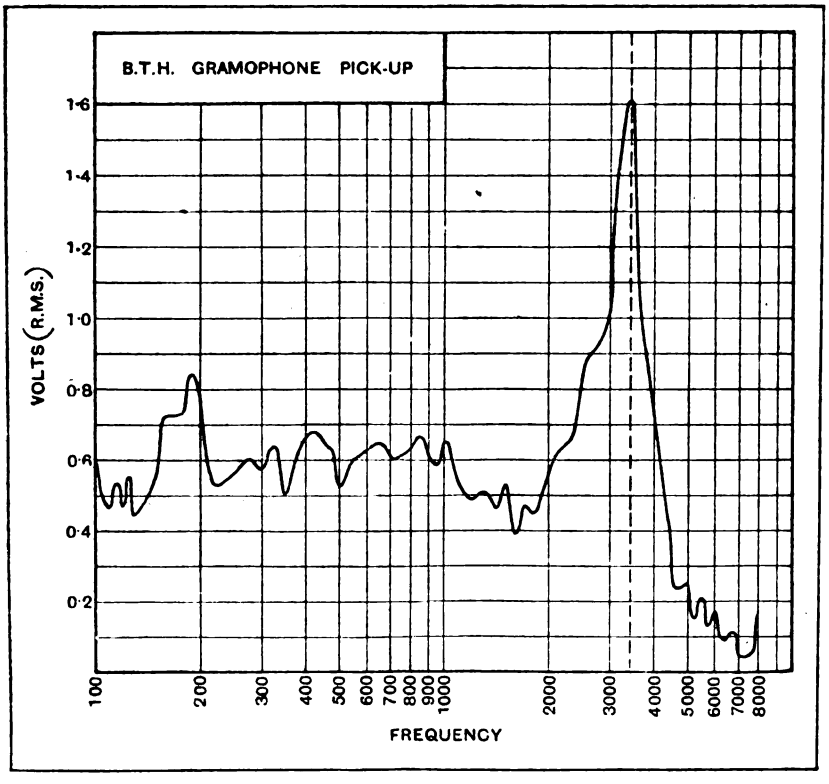
CHANGE OF ADDRESS.

The Epoch Radio Manufacturing Co., Ltd., 25, Laurence Pountney Lane, London, E.C.4, have removed to more commodious premises at 3, Farringdon Avenue, Ludgate Circus, London, E.C.4. The telephone numbers will be Central 1971 and 1972.



Output characteristic of B.T.H. pick-up, using H.M.V. "Half Tone" needle. Frequencies to the left of the dotted line represent the fundamentals used in music, so the pick-up has virtually a rising characteristic.

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THE NEON LAMP AS A STABILISER.

Practical Applications.

By S. O. PEARSON, B.Sc., A.M.I.E.E.

(Concluded from page 202 of last week's issue.)

NOW we must consider what happens when the useful load, represented by the plate currents of all the valves preceding the output stage, is connected in parallel with the neon lamp in the circuit of Fig. 4. We then have the equivalent circuit of Fig. 6.

Let E = voltage at eliminator output terminals.
V = reduced voltage applied to load.
I_1 = useful load current.
I_2 = current taken by the neon lamp.
$I = I_1 + I_2$ = total current.

We then have $V = E - IR$ as before

$$= E - (I_1 + I_2)\,R.$$

But it has already been shown that the current I_2 taken by the neon lamp is given by

$$I_2 = \frac{V - e}{r}$$

$$= \frac{V - 135}{2{,}500}$$ for the particular lamp tested, and so in this case

$$V = E - (I_1 + \frac{V - 135}{2{,}500})\,R \quad \ldots\ldots\ldots\ldots (3)$$

Knowing the eliminator voltage E, the equation (3) enables us to find the series resistance R that will be necessary to give any required voltage V at the load terminals for the normal value of load current I_1. For instance, suppose that with a load current of 15 milliamps. we require a pressure of 155 volts at the terminals, the eliminator voltage being 500: Then, substituting these values in equation (3) we get R = 15,000 ohms. With this value of series resistance we see from the curve of Fig. 5 that when the valve load is switched off, i.e., when $I_1 = 0$, the voltage increases from 155 to 186, and the current I_2 taken by the neon lamp, as shown by its characteristic curve (Fig. 2), increases from 8.2 to 20.7 milliamps. That is to say, in dropping the useful load current by 15 milliamps., the lamp current is increased by 12.5 milliamps., resulting in a net change of only 2.5 milliamps. in the current drawn from the eliminator; and so the voltage at the eliminator terminals will be practically unchanged.

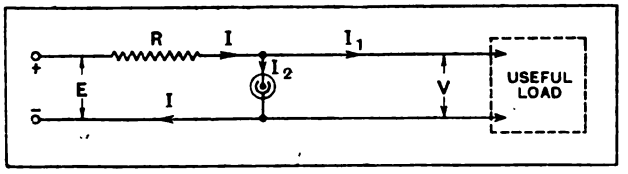

Fig. 6.—Equivalent circuit representing actual working conditions.

Conversely it can be shown in a similar manner that any change in voltage at the eliminator output terminals results in a relatively very small change of pressure across the neon lamp and the load in parallel with it. *The neon lamp may thus be looked upon as a sort of trap which prevents voltage changes at either end of the circuit from getting through to the other end, besides limiting to a small figure the voltage changes across the load itself.*

The latter effect is very clearly shown by curve A in Fig. 7, where the voltage at the load terminals is plotted against the load current. The figures were obtained by calculation from equation (3), rewritten in a more convenient form, thus:

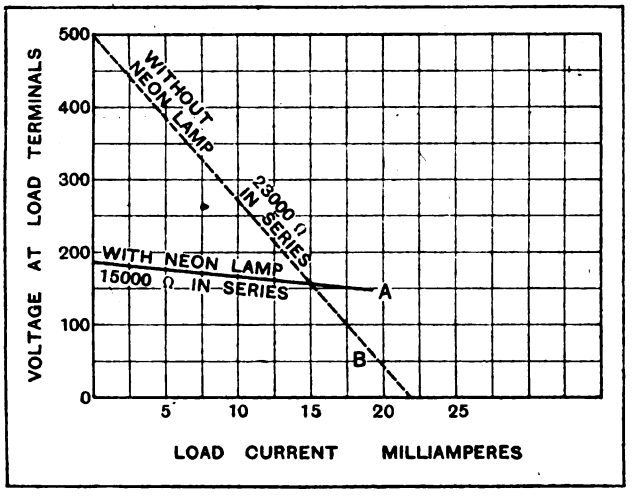

Fig. 7.—Two curves which show the marked improvement introduced by the inclusion of a neon lamp.

$$V = \frac{2{,}500\,(E - I_1 R) + 135\,R}{2{,}500 + R}$$

the series resistance being R = 15,000 ohms and the eliminator voltage 500. In order to emphasise the remarkable effect of the lamp, curve B has been added to show how the load voltage varies if the neon lamp is omitted. The series resistance in this case is again chosen to give 155 volts across the load with a current of 15 milliamps., viz.:

$$R = \frac{500 - 155}{0.015} = 23{,}000 \text{ ohms.}$$

Remarkable Voltage Regulation.

It should be noted that when the load current is reduced to zero the voltage builds up to 500, and that, although at 15 milliamps. the pressure may be 155 volts, it falls to zero for a current of 21.7 milliamps.!

Comparing the two arrangements then as regards voltage variation for a given change in current: (*a*)

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The Neon Lamp as a Stabiliser.—

with neon lamp in use and 15,000 ohms in series, a current change of 1 milliamp. results in a variation of 2.14 volts at the load; (*b*) without the neon lamp, but with 23,000 ohms in series, a current variation of 1 milliamp. is accompanied by a voltage change of 23—nearly eleven times as great!

Although the figures and results given above have been obtained by calculation, they have been checked by practical measurements which, without exception, agreed very closely.

Application to Normal Type of Receiver.

Although the foregoing remarks and calculations apply to the particular case where the output valve or valves require an anode voltage roughly twice as great as that needed by the preceding valves, the neon lamp can be equally well applied to the more common type of receiver where all the valves, except perhaps the detector, operate with plate voltages of the order of 160. In this case the series resistance R_2 of Fig. 1 is dispensed with, the neon lamp being connected directly across the eliminator output terminals as shown in Fig. 8.

The minimum voltage at which the current can be maintained through an ordinary neon lamp is not much less than 150, and therefore the system can only be applied to those receivers in which the voltage at the eliminator terminals does not fall below 150 with all valves on, unless a special neon lamp capable of running on lower voltages can be procured. However, a great many battery eliminators are designed to give at least 150 volts when on normal full load, so that in the majority of cases the arrangement can be used.

Order of Switching On.

It is common practice to switch on the valve filaments first and then the high tension, but when a neon lamp is used it is almost essential to switch on the H.T. before the filament current; otherwise the probabilities are that the neon lamp will not light at all. Take as an example a set requiring 160 volts on the plates of all valves other than the detector, and drawing a current of 15 milliamps. from the eliminator under ordinary conditions. With such a set, if the filaments were switched on before the high tension, the voltage at the output terminals of the eliminator would never exceed 160, and

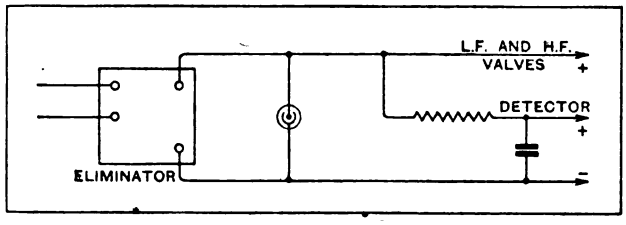

Fig. 8.—Application of neon lamp to eliminator and receiving set working on moderate voltage where no series step-down resistance is required.

a neon lamp with characteristics similar to the one considered above, connected in parallel, would not glow at all, and no stabilising effect would be obtained. On the other hand, if the H.T. is switched on without the filaments, the voltage across the eliminator terminals would probably build up to a figure in excess of 200 if no neon lamp were present. With the neon lamp in circuit, however, the glow would be established directly the voltage reached the critical starting voltage for the lamp. As shown by the characteristic curve of the lamp (Fig. 2), the glow will be maintained even though the voltage fall considerably when the lamp lights up. The

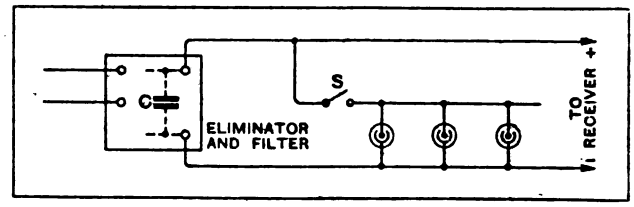

Fig. 9.—Arrangement for establishing the glow in two or more lamps in parallel where the resistance of the supply circuit is high. The eliminator is switched on first, then S is closed, and finally the filaments are switched on.

subsequent switching-on of the valve filaments and consumption of plate current will result in only a slight extra fall in voltage as explained above.

Two or More Neon Lamps in Parallel.

It would seem fairly obvious that for a particularly unstable set which refuses to be stabilised by a single neon lamp, two lamps or more may be connected in parallel across the circuit. However, it must be borne in mind that the use of a neon lamp will only cure oscillation set up on account of the high resistance of the eliminator circuits and will not cure a badly designed receiver where the trouble is due to feed-back effects within the amplifier itself. In theory the use of more than one neon lamp in parallel is thoroughly sound because it would have the same effect as connecting two or more floating batteries of equal E.M.F. across the circuit; but in practice it is not always a simple matter to get more than one lamp to glow in a circuit of this kind where the resistance is high. The reason is that the critical starting voltage for each lamp is not quite the same, and therefore as the voltage builds up after switching on, one of the lamps will suddenly light up and, due to the resistance of the circuit, pull the voltage down again before the remainder have a chance to establish a glow.

Obtaining the Starting Voltage.

The difficulty can often be overcome, however, by adopting the expedient of allowing a condenser of fairly large capacity to be charged up to a voltage well above the critical starting voltage of the most obstinate lamp, the lamps being temporarily disconnected as shown in Fig. 9 by the switch S. Fortunately the necessary condenser is already provided in the filter circuit, across the output terminals of the eliminator. The eliminator is first switched on with the isolating switch S open and filaments off; then, after a second or so, S is closed and all lamps should light. If not, the capacity of C is too small or the no-load voltage of the eliminator is insufficient. The latter can be checked by testing the lamps one at a time, the remainder being removed from their sockets.

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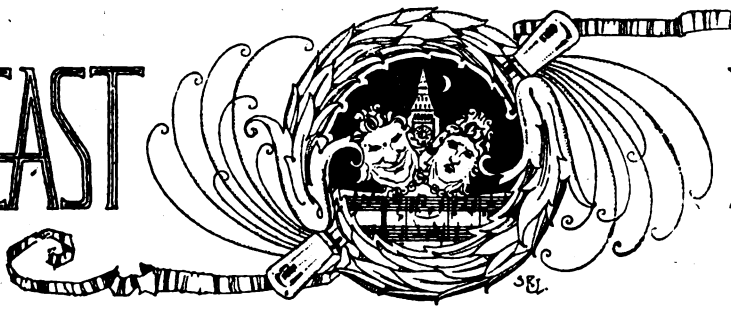
BROADCAST BREVITIES



By Our Special Correspondent.

Brookman's Park Gets Busy.—Fire Drill at H.Q.—Controversial Talks.

Enter the Regional Scheme.

Monday, September 16th, is the date definitely decided upon by the B.B.C. for the first publicly announced transmissions from the new London Regional station at Brookman's Park. This is two days later than the date I ventured to suggest in *The Wireless World* of August 14th.

To split hairs, it may be more accurate to say that the inaugural programme will go out on September 17th, the transmission beginning at 00.00 B.S.T. on that date; but no doubt Savoy Hill considers that homage is due to G.M.T.

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A Four Weeks' Change-over.

Starting off with an aerial power of 30 kW., London Regional will operate for one hour nightly, from midnight to 1 a.m., during a period of a fortnight from September 16th. During the following fortnight it will transmit the normal programmes from about 10.30 p.m. onwards, the exact time depending upon the occurrence of a suitable interval between programme items. The wavelength will be the same as 2LO's, viz., 356.3 metres.

At the end of four weeks, i.e., on October 14th, the new station will take over entirely from the existing Oxford Street transmitter, which will then close down.

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Troubles Anticipated.

Double transmissions from Brookman's Park must not be expected, I learn, until December, when the engineers have satisfied themselves that the single wavelength working is a success.

Two fruitful causes of complaint are likely to arise during the next month or two. In the first place, crystal users in the neighbourhood of Oxford Street who have been absorbing 2LO morning, noon and night without the slightest difficulty, will experience an aching void after October 14th. To console them, the B.B.C. has prepared a special tonic-talk pamphlet, available on request, which shows that, provided one's aerial is readjusted, there need be no occasion for such morbid ditties as "I dreamt I dwelt at Marble Arch."

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Alternative Programmes.

A second chorus of complaint is expected from North London listeners, who may experience difficulty in separating 5GB from the London Regional. Except in cases where unusually selective sets are employed, it is to be feared that dwellers on the northern heights may have to forgo an undisturbed alternative programme until Brookman's Park sends out its twin transmissions.

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"Outside" Broadcast.

Klaxon horns proclaimed a new form of "Surprise Item" on Wednesday last, when Savoy Hill held its first full dress fire drill. Within three minutes of the alarm, artistes, visitors, and all members of the staff found their way into the street, where they waited, self-conscious and hatless, until bidden to return by the whistle of Mr. Riley, the B.B.C.'s fire chief.

It is a pity, I think, that this "Outside Broadcast" was not included in the programmes. The silence of the deserted studio would have been most impressive.

FUTURE FEATURES.

London and Daventry.

SEPTEMBER 11TH.—Running Commentary on the St. Leger.
SEPTEMBER 12TH.—"Squirrel's Cage."
SEPTEMBER 14TH.—A Military Band Concert.

Daventry Exp. (5GB).

SEPTEMBER 8TH.—A Military Band Programme.
SEPTEMBER 11TH.—"Squirrel's Cage."
SEPTEMBER 13TH.—"Romance Unlimited," a match-making medley by Dorothy Eaves.
SEPTEMBER 14TH.—Programme of Students' Songs.

Cardiff.

SEPTEMBER 11TH.—A Welsh Programme.

Manchester.

SEPTEMBER 9TH.—Songs that Made History.

Newcastle.

SEPTEMBER 12TH.—An Irish Programme.

Glasgow.

SEPTEMBER 9TH.—A Scottish Concert.

Aberdeen.

SEPTEMBER 10TH.—"The Grenadier," a play by George Reston Malloch.

Belfast.

SEPTEMBER 14TH.—Programme of Old Favourites.

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Relays from Geneva

To-morrow (Thursday) will inaugurate the first of a series of four important weekly talks relayed to British listeners from the studio of Radio Genève, in which notable personalities at the League of Nations Assembly will give their impressions of the work carried out at Geneva. The speaker to-morrow will be the Rt. Hon. Arthur Henderson; other speakers in the series will be Mrs. M. A. Hamilton, M.P., Prof. P. J. Baker, M.P., and Viscount Cecil. I believe, also, that there is a possibility that the Prime Minister may find an opportunity to talk to British listeners from Geneva.

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"Giants" in the Studio.

The last vestige of the ban on controversy seems to have vanished with the inclusion in the programmes at the end of September of a new series of talks to be given at 9.15 on Monday evenings by some of the most original thinkers of the day. These will include Mr. H. G. Wells, Mr. George Bernard Shaw, Dean Inge, Sir Oliver Lodge, and Prof. J. B. S. Haldane. The talks will bear the title "Points of View," and it is understood that each speaker will give a candid account of his own philosophy of life in general, with possible excursions into the philosophies of other people.

In a typically Shavian letter to Savoy Hill, "G. B. S." has agreed to speak if he is allowed to say just what he likes!

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More National Lectures.

The Lord Chief Justice, the Rt. Hon. Lord Hewart, D.C.L., LL.D., is among the eminent authorities who have consented to broadcast National Lectures during the coming winter. The other lecturers will be the Master of Trinity, Sir J. J. Thomson, O.M., D.Sc., F.R.S., and Professor G. M. Trevelyan, C.B.E., Litt.D.

The dates and subjects are as follows:—

November 18th.—Prof. Trevelyan: "The Historical Aspect of the Union of England and Scotland, 1707."

January 27th.—Sir J. J. Thomson: "Tendencies of Recent Investigations in the Field of Physics."

March 24th.—Lord Hewart: "Law, Ethics and Legislation."

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"Prom" Broadcasts.

During September, Promenade Concerts will be relayed from Queen's Hall on the following dates:—

2LO, 5XX and other stations: September 5th, 7th, 9th, 11th, 13th, 17th, 20th, 23rd, and 26th. 5GB: September 4th, 6th, 10th, 12th, 14th, 16th, 18th, 21st, 24th, 25th, and 27th.

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CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS.

Sir,—As a transmitter since the days of Writtle and one of the original members of the T. and R. Society, I would like heartily to endorse Mr. J. Ashton Cooper's remarks.

I think there are a number of transmitters in this country who do not realise that the Postmaster-General will under no circumstances grant transmitting privileges for amusement purposes. That being so, if we wish to retain our licences we must treat them as a means of pursuing a scientific hobby.

The success or otherwise of the R.S.G.B., as in any other society, depends entirely on the efforts of its individual members. We elect our committee, also our area officials to look after the provinces. If they are not doing their work satisfactorily, we can turn them out at the next annual meeting.

I am afraid that the root of a lot of the trouble is that too many of the members are apathetic. If all the members of the R.S.G.B. would only get together and show some interest in the conduct and welfare of the Society, and air their grievances, if there be any, and take the trouble to elect the committee members they really want, the R.S.G.B. could satisfy any reasonably minded member, and, what is more, the Society has the added advantage of being already respected by the Post Office officials.

Now then, you fellows, let us have a little of the constructive criticism and less of the destructive!

Ilford, London J. W. COVENEY.

Sir,—Having read your editorial in the issue of August 21st, and also the letters appearing under correspondence, I would like to avail myself again of your correspondence columns.

First, let me say, regarding your editorial, that I quite agree that it is impossible for a journal such as yours to take sides with any one society, yet I still consider that undue prominence was allowed to anti-R.S.G.B. bodies, *e.g.*, the C.G. and the A.B.R.S., to rush into print with statements which have absolutely no foundation in fact.

Regarding the C.G., it is a very well-known fact that the reason for their very strong bias against the Radio Society is that they do not have the same privileges as the membership, it apparently being their idea that, whilst not paying the subscription due from a member, they should, nevertheless, be allowed to partake of the benefits of such membership.

Therefore it is, I think, safe to assume that very little credence will be attached to their statements.

With the A.B.R.S., however, the situation is very different, as here we have one society definitely attacking another through the columns of a journal and seeking to attach to itself the credit which rightly belongs to another.

Mr. Kemp, in his letter, tells us of what the A.B.R.S. has done for the amateur. Well, what has it done? I would submit that the answer is: Nothing, except talk.

As an offset to this, let us look at the record of the R.S.G.B. Let a transmitter look at his licence; he is allowed definite bands of waves; this is due to persistent effort on the part of the R.S.G.B. The 80-metre band is, I know, more or less closed, but in this case it is because of a definite stand by the P.M.G., and not, as suggested by the C.G., that the R.S.G.B. has "reserved" it for the use of members.

Again, take the greater measure of freedom in the matter of personal messages, and also the permission to use the word "test" as a general call.

Who obtained these privileges? Again, the R.S.G.B.; and, furthermore, I can state, from personal experience, that no stone will be left unturned in the continued efforts of the Society towards the helping of the cause of amateur radio.

Some people may say that the above are very small matters; that is as may be, but, nevertheless, they are steps in the right direction, and are more than any other society can claim to have done, and these are only illustrations from many similar efforts.

No, Mr. Editor, the trouble is not with the R.S.G.B.; it is still ready, and competent to lead, but obviously it is an uphill task when there are bodies, with an axe to grind, who are constantly doing their utmost to injure, and hinder, the work that the society is trying to do.

In conclusion, I would suggest that the amateurs of this country will, if they back it up, find that the Radio Society of Great Britain is, and always will be, ready to give of its best to the cause of amateur radio.

Croydon. CLEMENCE S. BRADLEY.

Sir,—Having read various correspondence on amateur status, I should like to comment upon the same from a fair and square view.

Many of the comments have been hurled at the R.S.G.B., and I do not think it is quite the game to blame the officials for not being in a position to grant or to stick out for more, or a better share of the ether. In some respects the position is far better than it was in 1927, and, as the R.S.G.B. advised its members, let us show them that the amateur can still, apart from the restrictions, come out on top.

We must not forget that the condition of the ether practically forced these restrictions, and many experimenters were forced to apply for other frequencies, due to the amount of Q.R.M. on other waves. If anybody is granted a permit without anything being known of the applicant's experience, and the R.S.G.B. supports such application, I am afraid the Postmaster-General would fail very soon to recognise the R.S.G.B. in any way.

I have always applied direct to the P.M.G., and I am sure that, provided you can satisfy him as to your abilities and your requests are reasonable, he will grant them.

So why blame the R.S.G.B. Let us make the best of a bad job and see what 1930 will bring. W. WICKS.

Hayes, Middlesex.

THE RADIO SHOW AND EXPERIMENTAL MODELS.

Sir,—Doubtless at this time the majority of manufacturers are concentrating their energies in perfecting their 1930 components. I would urge on them the futility of exhibiting these at the show in an experimental state, and would assure them that considerable annoyance results through exhibiting components that cannot possibly be supplied to the public for three or four months. If the idea is only to see if the article catches the public fancy, then I would advise the manufacturers to give up wireless and enter the toy trade.

Experimenters may favour a particular make, but they certainly are not subject to fancy. They know by experience that such a make is reliable and efficient and at any rate equal to others at the price. If a better component is available, however, at the same price, they will buy it. It is useless to show an article with bad characteristics and expect the public to buy it because it is put in a highly coloured box ornamented with pink parabolas. If it is a good firm, and characteristics are not issued, the public buy one or two, find out their mistake, and then—exit the firm's reputation. Beyond the fact that the anticipated furore is not created, the sale of other components suffers also.

As for the other class of manufacturer, he who cannot supply the demand, it is unfortunately true that the components he markets are of really good quality. Indeed, some experimenters would manage with old components for weeks on end in the hope of obtaining ultimately the particular article they favoured. It is up to the manufacturers, who assumedly know the value of their goods, to obtain a large enough stock of them before the article is put on the market. Summer is a slack season, and there is not a reason why they should wait until after the exhibition and then say that it is impossible to increase their staff to deal with a temporary rush. Surely they have sense enough to see this.

Further, to concentrate on the export demand is not fair to home trade. Will they realise this in good time?

Shortlands, Kent. HUGH A. RAMPTON.

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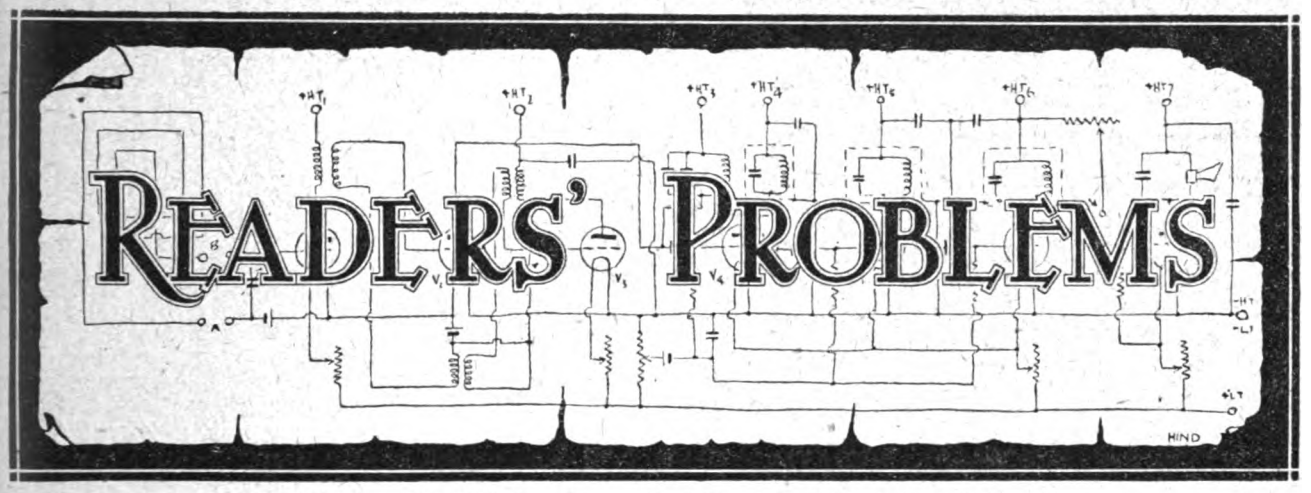

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

The Aerial as a Stabiliser.

My "Everyman Four" set worked well on a full-sized outside aerial, but now that I have moved into a flat, and consequently use a short inside aerial, I find it impossible to receive any transmission other than the local, for the reason that self oscillation is produced when the two circuits are brought into tune. Is the set suitable for use with my present type of aerial, and, if so, can you suggest the cause of instability?

S. E. F.

We expect that the H.F. valve was fairly close to the oscillation point when the damping effect of a full-sized aerial was applied, and that its present instability was entirely due to the removal of this load. The design of the set is such that it should be perfectly stable with a very short aerial, or even with no aerial at all, and consequently you should pay careful attention to the neutralising circuit, the disposition and wiring of the coils, and to the effectiveness of inter-stage screening. Before beginning to overhaul the set, it would be as well to assure yourself that the aerial lead-in wire does not pass in close proximity to the H.F. transformer, or, indeed, to the output end of the set.

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A 2-H.F. "Everyman Four."

Will you please say if it is possible to add a second stage of H.F. amplification to the original "Everyman Four" receiver, and, if so, give me a few hints as to how it can be done?

S. S. M.

Speaking from a strictly practical point of view, our answer must be that it is impossible to add a second high-efficiency H.F. amplifying valve. It would be obviously incorrect to say that the required alteration could not be made by rebuilding the H.F. side of the set, but to do this successfully would involve such drastic alterations that the remodelled receiver would bear little resemblance to the original. Vastly more complete screening and decoupling is necessary when one is aiming at an overall gain of perhaps 1,000 as compared with about forty times, and, in particular, special care has to be taken to avoid interaction between the input and output ends of the set.

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Two Volts from a Six-volt Accumulator.

Can you give the solution of my problem? On reconnecting my six-volt accumulator on its return from the charging station, signals could not be obtained, and on making voltage measurements it was found that the battery had dropped to about two volts. Although the cells are by no means new, they all appear to be in good condition, and, strange to say, each individual cell shows a reading of two volts.

K. M.

We can only conclude that, after your battery was charged, the inter-cell connecting straps were removed for cleaning purposes, and that they were afterwards incorrectly replaced, with the result that one cell is in opposition. Admittedly, the great majority of batteries are connected in such a way that it is impossible to make this mistake, but we have seen groups of cells arranged in such a way that it might occur.

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Tuned Anode *versus* Tuned Transformer.

I have read a recent article in your journal entitled "The Modern H.F. Valve," and have come to the conclusion that an H.F. transformer is always superior to the tuned anode arrangement as regards stage amplification. Am I right in this assumption, or is there a condition in which "T.A." is superior to "H.F.T."?

M. W. M.

Your statement may, generally speaking, be considered as correct enough, provided the ordinary tuned anode coupling is used, but it must be modified where the anode coil is tapped for the plate connection. A tuned anode coupling is theoretically equivalent to a 1:1 transformer, and this ratio only affords the greatest possible stage gain when the dynamic resistance of the tuning coil is equal to the A.C. resistance of the valve. A coil can easily be wound in which the dynamic resistance is of the order of 250,000 ohms; it can therefore be seen that with a triode having an A.C. resistance of some 30,000 ohms the tuned anode arrangement would give very poor amplification. With a screened valve if the A.C. resistance happens to equal the dynamic resistance of the tuning coil the tuned anode coupling is actually a little superior, as far as amplification is concerned, to the 1:1 transformer, as coupling losses between the primary and secondary windings are avoided. Isolation of the detector grid circuit from L.F. impulses and considerations of selectivity have generally rendered it expedient to forgo a small percentage of the amplification and use a double-wound transformer with a step-up ratio with screen-grid valves.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans can not be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Larger Condenser Wanted.

For temporary use, I have made up a det.-L.F. set with a commercial double-range tuning coil. The receiver did not reach the wavelength of 5GB, although the stations at the lower end of the broadcast waveband could be tuned in; accordingly, I added turns to the grid coil. With this alteration 5GB can be received but the minimum wavelength seems to be unduly high. Can you tell me what is wrong?

T. H. F.

In the first place, we would say that your tuner is almost certainly designed for a variable condenser of 0.0005 mfd.; it is safe to hazard a guess that you are using a considerably smaller capacity, and we would advise you to make a change.

Should you prefer to retain your present tuning capacity, it will be necessary to experiment with the number of added turns; unless incidental capacity across the grid circuit is exceptionally high, it should be possible to arrive at an inductance value that will enable you to cover the normal medium waveband with a 0.0003 mfd. condenser.

○○○○

Where Free Grid Bias Fails.

My set is the original "Everyman Four," in which a two-volt detector is used with six-volt valves in the remaining positions. I am thinking of substituting a modern low impedance "D" valve for the present detector, and should like to know what filament resistances to use for the free grid bias scheme. J. D.

The plan of obtaining grid bias voltage from the L.T. battery is hardly applicable when the set is modified as you suggest; the maximum obtainable bias voltage will not be greatly in excess of four volts, and this will be insufficient for a low impedance anode bend detector unless the H.T. pressure is reduced to something considerably below the optimum value.

For use with this particular set, it is unlikely that the newer type of valve will confer any very obvious benefits, but if you wish to use it, it will be necessary to modify the receiver by abandoning the free bias scheme, and making arrangements to apply the necessary pressure to the grid from a dry battery—either a separate unit or (preferably through a decoupling resistance) from the battery feeding the L.F. grids.

○○○○

Momentary Oscillation.

My four-valve set, fed from an H.T. eliminator, gives quite satisfactory results, but I notice that when switching off the filaments a shrill whistle, of momentary duration, is produced in the loud speaker. Can you tell me the cause of this, and will you also say where it suggests that something is wrong? P. C. L.

It is difficult to make a definite statement as to the cause of this effect, but the following explanation is at least plausible, and in more than one instance has been proved to be correct. In the average receiver the output valve consumes more anode current than do all the others put together, and, moreover, its filament is generally of a type which tends to cool more quickly on switching off than do those of the remaining valves. When the L.T. supply is interrupted consumption of current in the output anode circuit will fall off very quickly, and there will be a sudden rise of voltage on the anodes of the earlier valves. If this state of affairs is reached while their filaments are still hot enough to emit freely, it is quite likely that self-oscillation will be produced, although the set may, with normal anode voltages, be reasonably stable.

Regarding the second part of your question, we do not think that the effect described is an indication that anything is radically wrong, but it seems probable that there is at any rate some slight tendency towards instability, and it might be well to see if it is not possible to improve the effectiveness of your shielding and decoupling devices.

○○○○

"Kilo-Mag" Pick-up Connections.

Will you please suggest a method of connecting a pick-up to the "New Kilo-Mag Four" set—provided, of course, that the receiver is suitable for this addition? M. V. P. R.

In common with all other receivers having a detector followed by a single L.F. amplifier, this set can easily be modified for gramophone work, but care must be taken to choose a pick-up sufficiently sensitive to give an adequate output when followed by two amplifying stages—the maximum possible with sets of this type. As you will have gathered from a recent article dealing with commercial pick-ups, a large number of units satisfy this requirement.

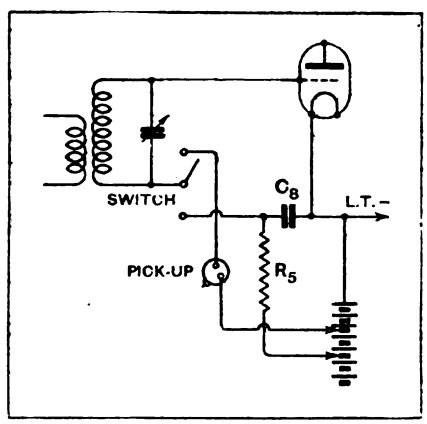

Fig. 1.—How to insert a gramophone pick-up in the detector grid circuit of the "New Kilo-Mag Four."

A suitable method of connection is shown in Fig. 1, from which you will see that a single-pole change-over switch is required; this component may be mounted through the base board and controlled through a push rod. An extra tapping on the grid bias battery, giving about half the voltage needed for detection, will be required for the valve normally performing the function of a rectifier when it is converted into a first stage amplifier.

Testing Made Easy.

I have just completed rather an ambitious set, with two H.F. stages, detector, and two L.F. magnifiers. The receiver is supplied with anode current through an eliminator, and I am sorry to say that preliminary tests seem to indicate that both H.F. and L.F. sides of the set are lacking in stability. If necessary, I can borrow a battery of H.T. accumulators for testing purposes. Do you think that their use would be of any advantage (as compared with an eliminator) when searching for the fault or faults?

N. P. H.

The golden rule in fault-finding is to eliminate as many uncertain factors as possible, and accordingly we strongly advise you to take advantage of your opportunity to use batteries while making the initial adjustments, if only for the reason that with this form of supply it is an easy matter to measure the voltage actually applied to the various anode circuits. Unless the set is stable, with a battery feed, it cannot be expected to work with an eliminator.

○○○○

Where Paper Condensers are Unsuitable.

I am under the impression that the use of paper condensers as intervalve couplings (in a resistance-coupled amplifier) is usually deprecated, on the grounds that their insulation resistance is usually rather lower than that of components having a mica dielectric. Is this correct? D. A. J.

We think that it is unwise to make a practice of using paper condensers for this purpose, in spite of the fact that the insulation resistance, particularly of the lower capacities, is generally of a high order. Admittedly, any small positive voltage on the grid of the succeeding valve (due to leakage) can be balanced out by increasing its negative bias, but it must not be forgotten that such leakage is generally a variable quantity.

Mica condensers are certainly the safest for intervalve couplings, as their insulation resistance is almost invariably both high and constant.

○○○○

Independent of Mains Voltage.

I gather that the "Flat Dwellers' A.C. Three," as described in your journal, is intended for use on 240-volt mains. My own supply is at 100 volts; will you please tell me what alterations will be necessary in the values of the voltage-dropping resistances?

T. L.

It should be made clear that the design of any A.C. set of this type is unaffected by supply mains voltage—always provided that the power transformer is suitably chosen. Certain voltages are required across the various secondary terminals, and these can be obtained with any input voltage by correct arrangement of the windings.

You will not find it necessary to make any alterations, but it will be essential for you to specify your mains voltage when ordering the power transformer.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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OLYMPIA SHOW COMPETITION.

A FORTNIGHT from to-day the annual Radio Show at Olympia will be in full swing, and the secrets of the manufacturers, jealously guarded for months past, will be revealed to the public. The importance of the Olympia Show grows from year to year, and one is amazed to look back only two or three years and observe the progress which has taken place in the design and production of apparatus for broadcast reception. It becomes increasingly difficult to decide what is the best apparatus in every class, but certainly very many visitors go to the Exhibition with the idea of arriving at such a decision.

The Wireless World is again conducting this year, in conjunction with the Olympia Show, a ballot amongst its readers, having as its object to decide what, in the opinion of those entering for the ballot, are the best products in various classes to be seen at the Show. The result of this competition is of very great interest, not only to the readers, but also to the whole of the wireless industry, for the manufacturers naturally welcome the collective opinion of readers of *The Wireless World* on so important a matter.

How to Enter.

The competition has again been organised on the basis that every entrant shall be entitled to one vote for what he considers to be the outstanding single exhibit at the Show in any classification, and to vote also for the best piece of apparatus in each of the several classes into which we divide the exhibits as a whole.

Our classification of the exhibits is as follows:—

(1) Complete receiver of 5 valves or more, that is to say, receivers exclusive of loud speaker and batteries—unless these should happen to be incorporated as part of the receiver.

(2) Complete receivers of 4 valves or less, similarly defined.

(3) Batteries of all kinds, including accumulators for both high tension and low tension.

(4) Mains supply units, both D.C. and A.C., and including those which provide filament heating circuits.

(5) Loud speakers of all types. (6) Valves.

(7) Other apparatus not classified above, also amplifiers, component parts such as transformers, condensers, tuning coils, resistances, etc.

Details of the competition will be found on the entry form, which will be published in the advertisement pages of the next three numbers of *The Wireless World*, which constitute the special show numbers reviewing the Exhibition. Entry forms will also be available at Olympia.

The Prizes.

A cash first prize of £50 will be awarded by *The Wireless World*, as last year, to the competitor whose vote agrees with the opinion of the majority in the selection of the outstanding single exhibit, and also in the largest number of classes. In addition, second, third, fourth, and fifth prizes to the total value of a further £50 in the form of vouchers for the purchase of apparatus will be presented.

Voting for apparatus is, by the rules of the competition, confined to products exhibited at the Olympia Show, and competitors should bear in mind, when completing their ballot forms, that choice should be guided largely by a consideration of the value of the apparatus at the price asked for it.

We hope that every reader of *The Wireless World* will enter for the competition, as the value of the results must necessarily be proportional to the number of voters.

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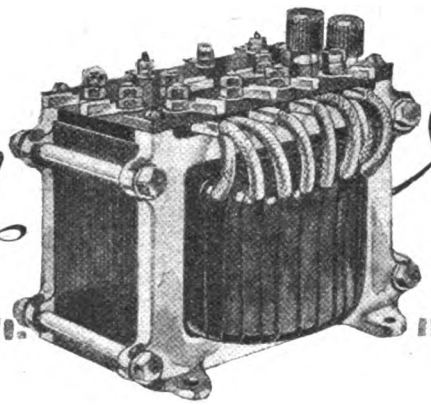
The Design of A.C. Mains Sets



A Simple Explanation of the Underlying Principles.

By W. T. COCKING.

IN a few years' time receivers operated from A.C. mains will be practically universal, except in remote districts where there is no electric supply available. This would be the case now if it were not for the innumerably different A.C. supplies in this country; but these are rapidly becoming more standardised, at least in frequency. Direct current, however, still remains a problem; such, in fact, that a set with a powerful output stage cannot be worked economically. The voltage of an A.C. supply is not really important, as transformers can be wound for any voltage, although if it were standardised the necessary apparatus would be more generally available, and, more important still, it would be cheaper. In America, due to the uniformity of the supply mains, mains-operated sets are becoming almost universal.

Advantages of Mains Drive.

Unless one has used a mains-operated set it is hard to realise its convenience. It is always ready for use; it requires no attention beyond very occasional renewal of the valves; there is no accumulator to run down just when a particularly interesting item is being broadcast; there are no high-tension batteries to renew; and the valves are always being worked with their correct high- and low-tension voltages.

Many people seem to think that a mains-operated set is difficult to design and build. It is, of course, more difficult than a battery-operated set, but the difficulties are so slight that they need not deter anyone capable of designing a battery set from attempting a mains set. If the proper precautions are taken to ensure that the apparatus conforms to the regulations of the Institute of Electrical Engineers, there is no danger whatever of getting shocks. As far as results are concerned, they will be better with a mains set than with a battery-operated one, for not only have mains valves better characteristics than the battery-heated type, but when mains are used there is little object in limiting the high-tension voltage to the low figure necessary when dry batteries are used, so that a greater undistorted power output can be obtained economically.

Although the building of the complete receiver with mains equipment into a single cabinet is obviously very convenient, the writer favours a two-cabinet arrangement. One cabinet contains the receiver and the grid bias arrangements, while the other, which may well be of steel, contains the complete power unit.

Coming to the actual designing of the receiver, there is no great difference between a mains-operated set and one worked completely from batteries. What difference there is exists only in the filament circuit and the arrangements for grid bias.

The rules for design are simple. Design the set on paper first, exactly as for battery working, but omit all filament connections. Choose the valves and coupling components in the usual way, and decide upon the values for H.T. and grid bias which each valve will require. Then find out from the valve curves what the anode current for each valve will be.

The next point—and this is where a mains set becomes more complicated than a battery set—is to provide these potentials. The maximum current which the set will require is known, for it is the sum of all the separate anode currents; and the maximum voltage is that of the H.T. required for the power valve plus the amount of its grid bias—that is, the eliminator output voltage must equal the sum of the H.T. and grid bias voltages for the last valve. Now, knowing the eliminator output—for it must be built to give this output—the values for the anode feed and grid bias resistances can be calculated. The whole point, if the finished receiver is to give real satisfaction, is that back-coupling must be completely eliminated. A mains set is more prone to back-coupling than one operated from batteries, for several reasons; mains valves are usually more efficient, thus giving more amplification per stage, which means that precautions against back-coupling must be greater; in addition, there are more places where back-coupling can occur, for it can take place not only in the anode circuits but in the grid and *filament* circuits also.

Back-coupling in anode circuits can be cured in exactly the same way as with a battery-operated set, by the addition of anode feed resistances; as the valves may be more efficient the resistances should have a higher value, but this is not usually possible, so it is best to use a separate

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The Design of A.C. Mains Sets.—

smoothing circuit for each valve. The cost is not so very much greater, as resistances and condensers can be used for all valves other than the detector and power stages.

Back-coupling in grid circuits can be cured very easily; it is only necessary to use one resistance and one fixed condenser in each grid circuit to obtain complete immunity from feed-back troubles here. The resistance can be of the grid-leak type, and as long as it is fairly high its value does not matter much. The requirement is that its resistance must be high in comparison with the reactance of the condenser at the lowest frequency which the set will amplify. The connections are shown in Fig. 1, where R is the filter resistance, C the filter condenser, and R_1 the grid bias resistance. Very good values for R and C are 0.25 meg. and 1 mfd. respectively; these values are suitable for any set, but the value for R_1 must be calculated afresh for every different valve.

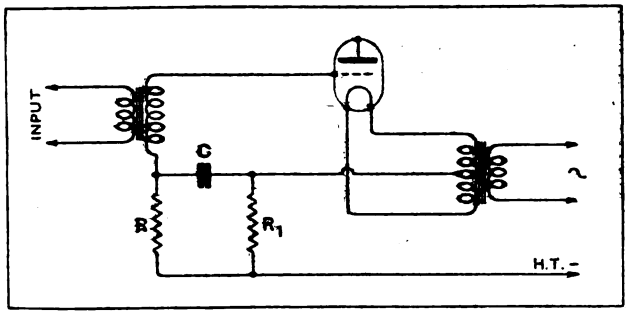

Fig. 1.—How to decouple the grid circuit of a valve deriving its grid bias and filament current from A.C. mains.

Back-coupling in filament circuits is at first sight not so obvious; it was first brought to the writer's notice by motor-boating in a set which was otherwise perfectly filtered. In an A.C. set the grid and anode return leads are all connected either to the slider of a potentiometer across the filaments or to the centre tap of the filament transformer. These components all have a resistance, and the passage of currents through it sets up potentials which are communicated to the previous valves in the set. It is impossible to provide an economical filter here, but the difficulty can be got over in another way. The best way—for it is one which completely eliminates the trouble—is to run each valve from a separate winding on the transformer. This is not always possible, in which case there is no alternative but to use valves of the indirectly heated cathode type, with which the trouble does not occur, as all return leads are taken directly to the cathodes.

Separate Filament Windings.

In practice, however, it is not always desirable to use this type of valve throughout a receiver, and the writer has found that the best results are obtained when two or three separate transformer windings are used with a mixed lot of valves. Ordinary 6-volt power valves for the output stage are recommended, although if their power output is sufficient there is no objection to using the four-volt type, the 0.8-volt type for the low-frequency stage, and 4-volt indirectly heated cathode type for the rectifier. For the H.F. stage it does not matter so much, as long as the H.F. couplings will not pass low-frequency currents; but the indirectly heated type are best, for with them it is easier to arrange grid bias. Another advantage of using as many separate windings on the transformer as possible is that it simplifies the grid bias arrangements considerably.

The next piece of work to be done in the designing is to calculate the anode feed resistances necessary for breaking down the H.T. volts for the early valves (no resistance is needed for the last valve). The values for these resistances may be found by subtracting the sum of the grid bias voltage and the required anode voltage from the eliminator output voltage, and dividing the result by the anode current, expressed in amperes, as in the following example: Suppose the required anode voltage is 120, the grid bias voltage 6, and the eliminator output voltage 270, while the anode current is 5 mA. (0.005 ampere); then the volts to be dropped in the resistance are $270-(120+6)=144$, and the required resistance $=144/0.005=28{,}800$ ohms.

The value for the grid bias resistances can be found in a simple manner provided that no current other than the anode current for that particular valve passes through the resistance; that is, no other valve must be worked from the same filament winding unless it be a grid rectifier requiring no grid bias. The required resistances are found by dividing the grid bias in volts by the anode current in amperes, as in the following example: Let us suppose that the bias required is 6 volts and that the anode current is 5 mA.; therefore the resistance $=6/0.005=1{,}200$ ohms.

The anode feed resistances can always be worked out as described above, but when more than one valve is

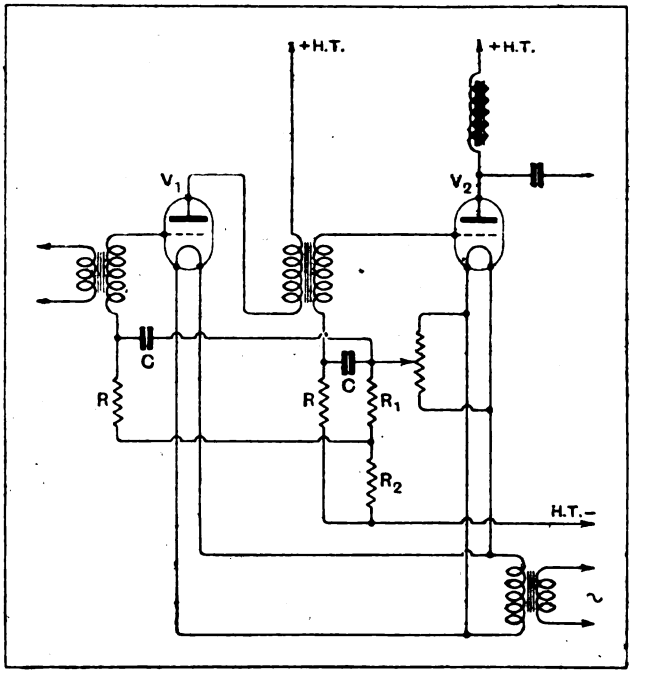

Fig. 2.—A two-valve amplifier shorn of its complications. Both valves are run from the same winding of the transformer.

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The Design of A.C. Mains Sets.—

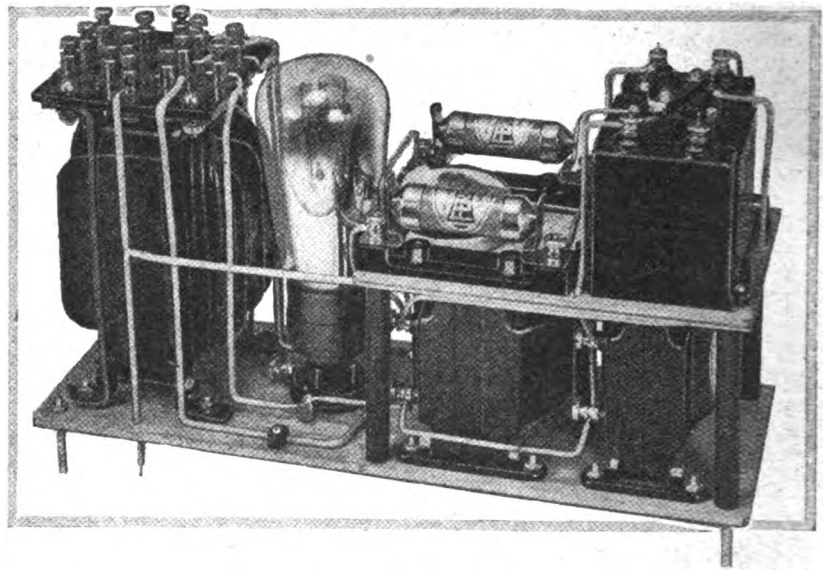
worked from the same filament winding, and each requires grid bias, the resistances for the latter must be calculated in a different manner.

In Fig. 2 is shown the skeleton circuit of a two-valve amplifier in which both valves are run from the same winding of the transformer; R and C are the filter resistances and condensers, while R_1 and R_2 are the bias resistances. It is required to find the values for these resistances. Let the anode current of V_1 be Ia_1, and that of V_2 be Ia_2; the total resistance which will provide the bias for V_2 is (R_1+R_2), and the total current through it is (Ia_1+Ia_2). Therefore the bias voltage for V_2 is $(R_1+R_2)(Ia_1+Ia_2)$. But the bias voltage for V_1 is provided by the drop across R_1 only; it therefore equals $(Ia_1+Ia_2)R_1$. As an example, suppose that the valves require the following voltages and currents:—Anode current of V_1 is 5 mA., anode current of V_2 is 24 mA., bias voltage for V_1 is 6 volts, and bias voltage for V_2 is 27 volts. Then $(Ia_1+Ia_2)=(5+24)=29$ mA. $=0.029$ ampere and $(R_1+R_2)=27/0.029=930$ ohms and $R_1=6/0.029=206$ ohms, therefore $R_2=930-206=724$ ohms.

When working valves from A.C., if ordinary power valves are used in the last stage, it must not be forgotten that the negative grid bias which is correct for battery working must be increased by an amount equal to half the filament voltage—that is, for a 6-volt valve, by 3 volts.

In calculating the biasing resistances, unless the potentiometer across the filaments is of very low resistance it must be taken into account. The anode current passes through it, and the voltage drop across it will be in the same direction as that across the proper bias resistance, with the result that the negative bias will be increased. It must not be forgotten that its resistance is less than that marked on it, for the marked resistance is that between the ends of the winding, while the effective resistance when connected in circuit is that between the slider and the valve filament. The slider will be connected to the centre of the potentiometer, which means that the two halves are virtually in parallel, so that the effective resistance of a 400-ohm potentiometer will be 100 ohms. It is true that in many cases this resistance will make no appreciable difference, but when more than one valve is being run from the same filament supply, and the anode current is fairly heavy, it may make a big difference. It is worthy of note that many American sets use potentiometers of 20 ohms resistance, which means an effective resistance of only 5 ohms. Another advantage of using a low resistance potentiometer is that the danger of back-coupling is greatly decreased; in practice, with a two-valve amplifier which will amplify the bass, when both valves are run from the same filament winding and a 400-ohm potentiometer is used, motor-boating occurs, although all the other circuits are effectively filtered. With one particular set where no potentiometer was used, even the resistance of the transformer secondary, a centre-tapped winding, was sufficient to give bad motor-boating. It is these troubles that have made the writer always recommend the use of separate transformer windings for supplying the detector and each of the low-frequency stages. It does not greatly increase the cost, and it gives complete freedom from all biasing and motor-boating troubles.

(*To be concluded.*)



The rectifier and smoothing unit of the "Flat Dweller's A.C. Three," an all-mains receiver described in our issues of May 1st and 8th, 1929.

PLUS OR MINUS?

A Note on By-pass Condenser Return Leads.

IN a receiver embodying a single stage of screen-grid high-frequency amplification that was recently set up, persistent oscillation that could not be traced to any of the usual sources was experienced. Eventually, after many hours of work, it was noticed that, although all other by-pass condensers had been taken direct to the negative filament leg of the valve, the condenser between screen-grid and filament had been brought to the positive side instead of the negative. On changing this connection over, as a last resource, the receiver instantly subsided into perfect behaviour.

It must be admitted that extremely low-loss tuned circuits were in use, and that the precaution of decapping both high-frequency and detector valves had been taken for the sake of cutting down dielectric losses to the minimum, but even so it seemed hardly to be expected that so trifling a detail should be enough to render the set unworkable. Nevertheless, such was the case, and the experience is published to draw the attention of others who may also be contending with unaccountable oscillation to a point that might very easily be overlooked.

A. L. M. S.

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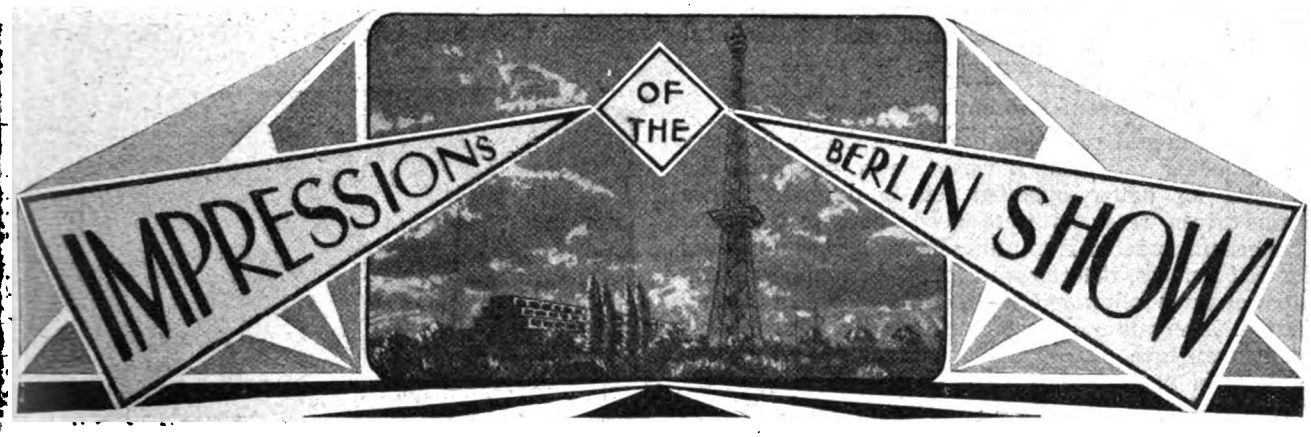


A Wide Range of Screen-Grid Mains-Driven Sets but Few Portables.

IT is perhaps only natural that, when visiting the Berlin Radio Show, which opened on August 30th, the inclination was to look at every aspect of the Exhibition in terms of comparison with our own Olympia Radio Show, especially when our own Show is to follow so quickly after that of Berlin.

The fact that an important section of the Exhibition is devoted to a display arranged by the German Post Office creates a strong impression, which subsequent observations do nothing to dispel, that the Berlin Radio Show is very strongly supported and encouraged by the Post Office and the Government. It is more a national Exhibition than our own can be considered to be in this respect, because at home we never quite get away from the feeling that the Post Office and the authorities take no part or interest in the Exhibition, whilst the B.B.C. is in a position rather aloof, after the style of an independent exhibitor.

Telefunken screen-grid valve. The glass bulb is covered with an earthed metallic coating which reduces the residual inter-electrode capacity.

Perhaps time will remedy this state of affairs, but at the moment the British wireless industry is certainly at a great disadvantage compared with our German colleagues in so far as official support and encouragement are concerned.

The special exhibit of the German Post Office included a duplicate of the apparatus now installed in Berlin, whereby the stations of Berlin, Stettin, and Magdeburg, all operate on the same wavelength. The control frequency is generated at the Berlin station and passed by ordinary cable to the two other stations. This system is also being operated with other groups of stations in Germany, and is proving satisfactory. The grouped stations have a common wavelength, but are independent so far as programmes are concerned, or they can transmit simultaneous programmes if desired.

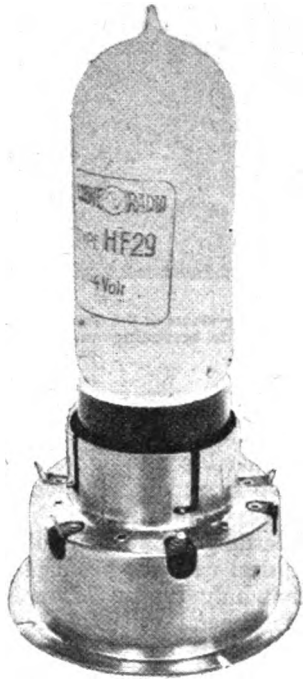
Another exhibit of special interest was a duplicate of the German short-wave "world transmitter," which has so successfully established communication with South America and other distant parts of the world.

Next should be mentioned a special short-wave receiver designed by Telefunken for the Broadcasting Company, a particular advantage of which is a new method of controlling fading and ensuring a constant signal value. Details of the circuit are not yet available for publication, but will no doubt be released later on.

Adjoining these exhibits is a room devoted to a series of demonstration stands to make public the present state of progress of television, as illustrated by several of the systems now developed, including Baird, Mihaly, Nipkow, and Karolus-Telefunken. The room is darkened so that projections can be seen through apertures in the sides of the walls of the stands enclosing the apparatus.

Utilitarian rather than Decorative Apparatus.

Germany is an eminently practical country, and so it may not seem surprising that the receivers have had more attention paid to their technical design than to outward appearances. There are, of course, many exceptions, but, taken as a



New Loewe multiple valve with metal-coated bulb and screened base.

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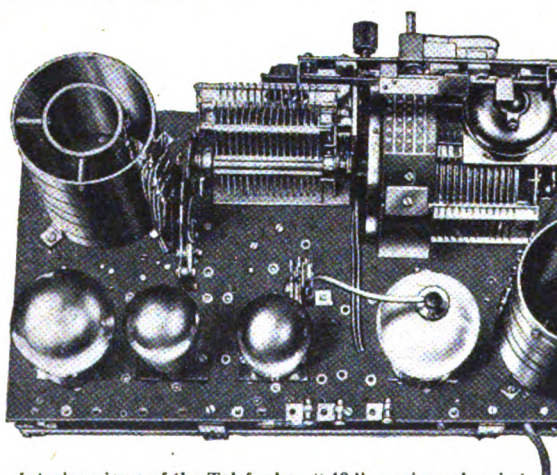
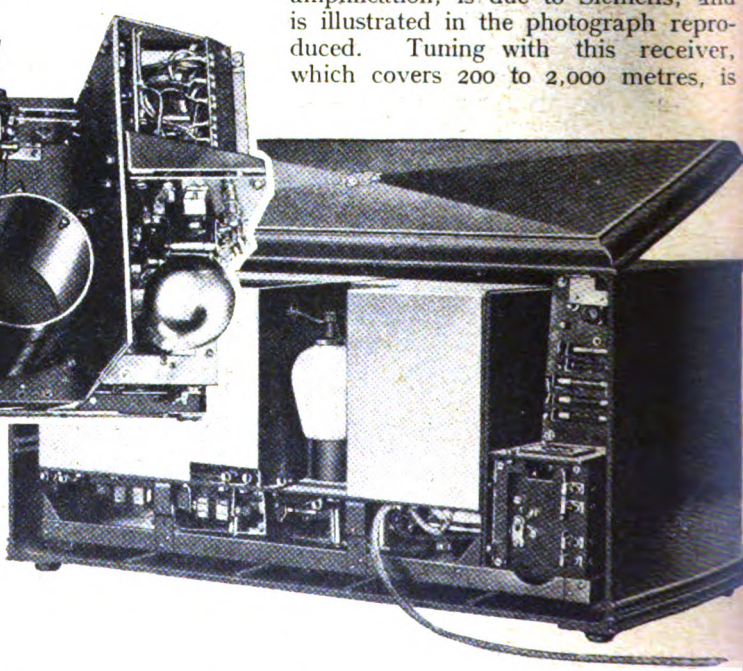
Impressions of the Berlin Show.—

whole, the artistic merit of the exteriors of the sets has taken second place to electrical and mechanical efficiency.

Screen-grid Mains Sets.

The screen-grid valve has been incorporated in many of the better sets, and it would seem, too, that the demand for battery-operated sets is declining, since mains-driven receivers were everywhere to the fore. The general practice is to utilise indirectly heated valves for H.F. stages, detector and first L.F. amplifier, with a power valve following having a heavy filament directly heated. Alternating current being more general in Germany than here, D.C.-operated sets are scarce. Telefunken, in the manufacture of screen-grid indirectly heated valves, have adopted a method of metallising the glass bulb, the bulb being connected electrically to the negative of the filament. The purpose of rendering the bulb a conductor is to reduce the residual inter-electrode capacity. The manufacturers of the Loewe multiple valves have also employed this method, but in this case for the different object of screening the valve and the couplings included in the valves from one another and from other parts of the receiver, the metallised glass bulb being again connected so as to be at earth potential. It is stated that in the Loewe valve this process has permitted an increase in stage gain of about 70 per cent.

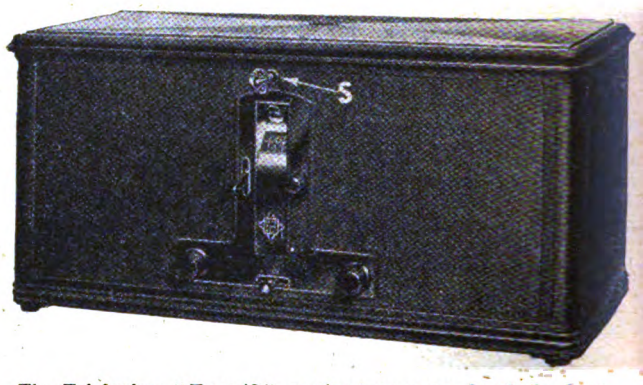




Interior views of the Telefunken "40" receiver showing elaborate screening and mass-production methods of manufacture.

The gentral introduction of the screen-grid valve has brought with it, naturally, problems of metal screening; here the manufacturers have in some cases been particularly thorough.

It is quite impossible in the space available for recording impressions of the Show to attempt to deal with the products shown on over 400 stands, so that only typical examples can be taken to illustrate the general trend of design. The "Telefunken 40" receiver is a new product, and the accompanying illustrations give a good idea of its construction. The valve with the frosted appearance is the metallised screen-grid valve, and is indirectly heated. It is followed by detector and first L.F., both indirectly heated, and finally a power valve directly heated. On the right is seen the rectifier. Coils and condensers are carefully screened.



The Telefunken "Type 40" receiver—an example of the best—A.C. mains-driven sets now popular in Germany. The set cannot be put into operation until the cabinet is locked by the key switch S.

The wavelength range is 200 to 2,000 metres. A point of interest is a key which operates a switch lock, so that the set is only "live" when the lid is closed and locked.

A New Tuning Method.

Another receiver of interest, which also operates from the mains and includes a screen-grid valve for H.F. amplification, is due to Siemens, and is illustrated in the photograph reproduced. Tuning with this receiver, which covers 200 to 2,000 metres, is by means of variometers coupled to variable condensers, and as the control knobs are rotated the proportion of inductance to capacity is correctly maintained and amplification remains constant through the wave range. The screening of the variometers and condensers is very complete, as the illustration shows.

Quite a number of receivers employ metal lids which

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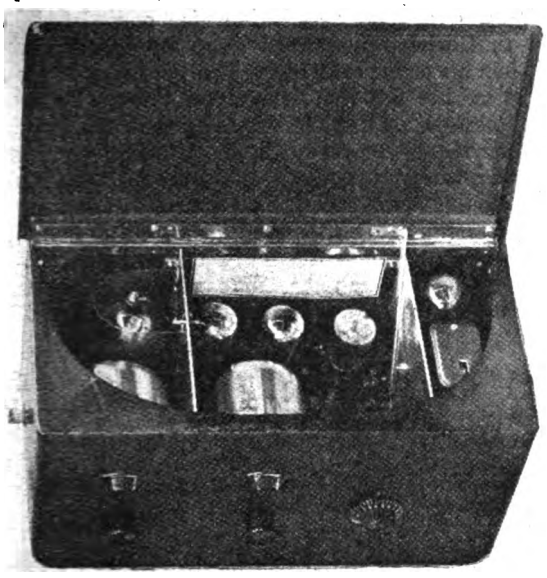
Impressions of the Berlin Show.—

close down over the apparatus on to a wood or metal baseboard, on which the components are mounted. The arrangement is very similar to that adopted in recent *Wireless World* set designs, except that the screening provided is not so complete in the German sets, as the partitions separating stages are not incorporated in the metal lid, but stand up from the base so that complete screening where the uprights join the lid cannot be ensured. The metal cases are mostly treated to represent wood grain, and are hard to distinguish from polished wood except by close inspection. German metal work is particularly good, and this is, perhaps, one reason why the great majority of the sets are metal



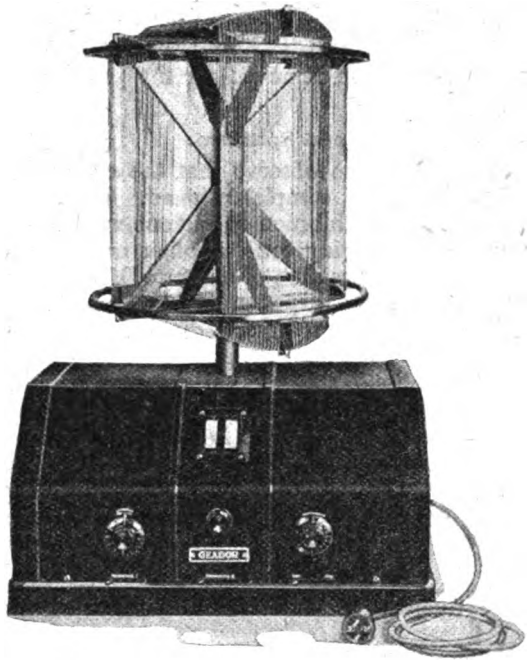
Siemens screen-grid valve receiver in which tuning is effected by a combination of variometers and variable condensers. Uniformity of H.F. amplification from 200 to 2,000 metres is claimed for this system.

cased, though there are outstanding examples in the two sets referred to above, namely, Telefunken and Siemens, where the whole cabinet is of moulded material made in two pieces, the box and lid, and beautifully finished.

Frame aerial receivers do not appear to be popular, as very few examples were to be seen. The same observation applies to portable receivers, and we learned that these have never been popular with the German public.

From amongst the few frame aerial sets we would mention the A.E.G. (Allgemeine Electricitäts-Gesellschaft) five-valve receiver operating from the mains and having two stages of screen-grid amplification, detector, and two L.F. stages, all valves except the output valve being indirectly heated.

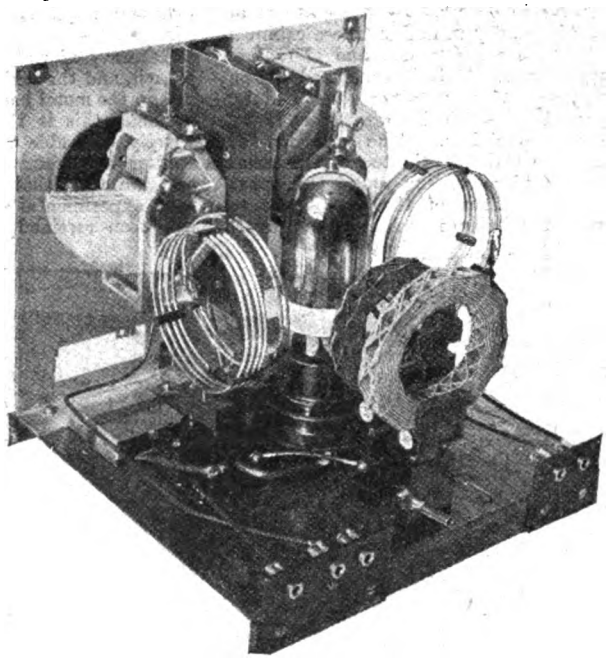
Another example of a frame aerial set is that of " De Te We," which is an eight-valve mains-operated superheterodyne. The same firm also exhibits a universal short-wave receiver also operating on the superhet. principle. The wave range is from 10 to 100 metres. The coils for the wave ranges are contained in a circular holder with stud contacts on the side. An edgewise rotating drum makes contact with the studs for different wavelength ranges, whilst reaction is provided by a coil with variable coupling to the various coils. The design



A.E.G. mains-operated five-valve frame aerial set. There are two stages with screen-grid valves followed by a detector and two L.F. stages. With the exception of the last stage, indirectly heated valves are used throughout.

is not according to accepted short-wave practice, but a very good performance is claimed for the set.

A short-wave unit removed from its case is illustrated in the photograph. This is made by Loewe Radio, and incorporates a new Loewe valve, which has connections



Loewe short-wave unit; wave-range, 16 to 60 metres. Parts of the screening system have been removed for the purpose of this photograph.

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Impressions of the Berlin Show.—

for external couplings instead of the couplings being associated within the bulb in the usual way with valves of this type. This unit is intended to be followed by an amplifier, and the wavelength range without change of coils is from about 16 to 60 metres. The screening for the coils has been removed for the purpose of the photograph.

Loud Speakers.

It was interesting to observe that the ordinary horn loud speaker appears completely dead. It was necessary to search the Exhibition to see one at all. Manufacturers are all showing cone or other non-horn types with, perhaps, the exception of one firm, Lenzola, which specialises in a folded exponential horn which, on demonstration with a moving-coil diaphragm unit, certainly gave very satisfactory reproduction. The ability to demonstrate loud speakers in cubicles behind the stands is a great advantage to exhibitors, though perhaps not to visitors as a whole. The moving-coil loud speaker is extremely popular, and many types were to be seen.

Amongst accessories an electrostatically screened frame aerial designed by M. von Ardenne attracted attention.[1]

[1] Referred to elsewhere in this issue.

A survey of the Exhibition as a whole leads to the conclusion that Germany is making very great progress in the production of broadcasting receiving apparatus, but there is not very strong evidence of originality in design. Quite a number of sets, although manufactured on German lines, are strongly reminiscent of American products, whilst some apparatus of types already familiar to us in this country are now new in Germany.

German methods of manufacture are certainly interesting, though probably less pleasing to an English visitor than the more substantially constructed, though probably more bulky and expensive, British product. Metal stamping work and mouldings of all kinds have been developed to a fine art, and in few sets where quantity production is considered do we find that wiring has been done by hand except where it has been unavoidable. The tendency is for all wiring before the low-frequency amplifier to be metal ribbon riveted on an insulating material, which is probably all produced in one or two automatic processes. Post-detector wiring of the L.F. amplifier is often cabled as in telephone work.

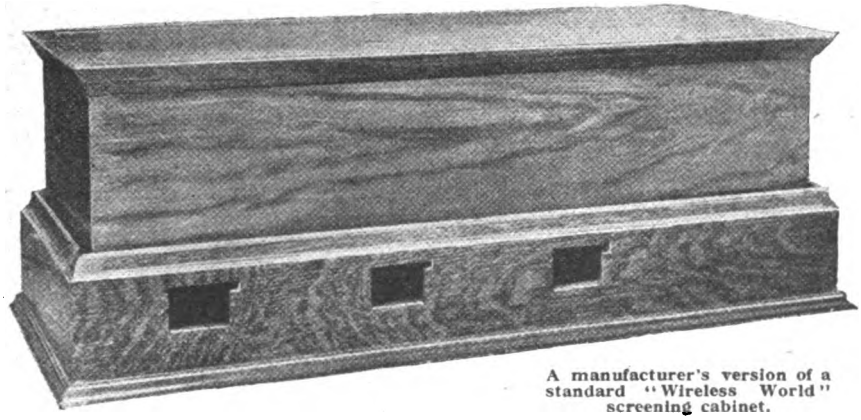
It is interesting to remember that, unlike America, Germany has the same problem in receiver design which confronts ourselves, namely, that provision must be made for both long and short wavelength reception.

NEW METAL SCREENING CABINETS.

A Commercial Design of the "Wireless World" Screening Box.

THERE is no reason why screening containers built in conformity with the general principles laid down in this journal and used for the Kilo-Mag IV and Record III receivers should not be decorative in design. By the exercise of a little ingenuity in design, these cabinets can be both workmanlike and attractive in appearance. This is confirmed by an examination of a container submitted by Messrs. Rigby & Woolfenden, Sheet Metal Workers, Rochdale. The addition of a flared extension to the top of the metal cover and of a beading round the upper projecting surface of the base tends to improve the balance and artistic proportions of the whole, while the practice of finishing the metal in imitation oak or whatever is required to harmonise with the wooden base makes the container sufficiently attractive to satisfy the most exacting requirements. It is priced at 57s. 6d.

Accuracy of workmanship is beyond reproach, and the width of the various channels in the metal base is perfectly uniform, although this is rather greater than is strictly desirable in cases where perfect sealing is necessary. The makers point out, however, that the cabinet submitted is an experimental specimen, and that this has been rectified in commercial models in the form in which they will be supplied to the public.



A manufacturer's version of a standard "Wireless World" screening cabinet.

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THE NEW COSSOR VALVES.

THE Cossor programme for the coming autumn season provides for the production of no fewer than thirty-five different types of receiving valves. This range is made up of indirectly and battery-heated valves, and includes pentodes. In each of the two-, four-, and six-volt classes there are six types—the "S.G.," "R.C.," "H.F.," "L.F.," "P," and "X.P." While the filament current is in most cases 0.1 ampere, an increase is made to 0.2 and 0.3 ampere for the "P" and "X.P." types in the two-volt class, and to 0.15 ampere for the "X.P." in the four-volt class. To compensate for the small increase in current consumption, the power output of the "P." and "X.P." types is correspondingly increased.

The "S.G." all have an amplification factor of 200 with an A.C. resistance of 200,000 ohms, and should therefore give a single stage amplification of over 70 when used with a H.F. transformer ratio of 1 to 3. This ratio is adopted in order to provide adequate selectivity while avoiding the possibilities of oscillation. Of particular interest is the indirectly heated screen-grid valve, the "M.S.G.41." A H.F. stage gain approaching 150 is obtainable under the conditions just mentioned.

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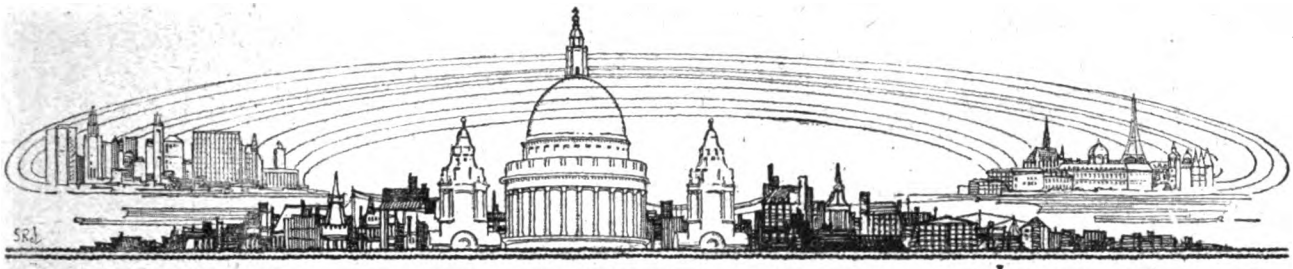

CURRENT TOPICS

Events of the Week in Brief Review.

THE SHEEP AND THE GOAT.

A distinction was drawn in the Birmingham Police Court recently between defendants who had installed unlicensed wireless sets and one who had committed the additional offence of operating the set. He was fined £3, the others being mulcted of £2 each.

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A.C. SETS FOR IRELAND.

Now that the Shannon Electricity Scheme is making progress, the talk in Irish radio circles is turning upon the approaching era of the A.C. mains-operated set.

During the last fourteen months, says *Irish Radio News*, the construction of the networks has progressed steadily and new works have been completed in nearly sixty towns.

It is expected that current will be available for certain towns before the end of the year.

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BAIRD TELEVISION TESTS.

We learn from the Baird Television Development Company that it has been decided to accept the proposal of the Postmaster-General, Mr. Lees Smith, and of the British Broadcasting Corporation to permit five half-hourly periods per week for experimental television transmission from a B.B.C. station. At the time of going to press no definite programme of tests has been prepared.

It is understood that nightly television tests are about to take place at the Brussels broadcasting station between 10.30 and 11.30.

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WIRELESS-EQUIPPED ARK.

According to a correspondent of *The Jewish Chronicle*, the Adventist body in Boston, U.S.A., foresees a world flood in the near future, and is therefore planning a luxurious and up-to-date Ark which is to be fitted with radio apparatus. The question is asked, If the world flood does occur, with whom will the Ark exchange wireless messages?

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FOREIGN SETS: NO MARKS REQUIRED.

The application made to the Board of Trade for the marking with an indication of origin of imported wireless receiving sets, components, and accessories has been withdrawn.

THE RADIO TRUMPET.

From the *Exchange and Mart* :—
Wireless : Cornet, 4-valve . . .
Is this a new all-metal portable?

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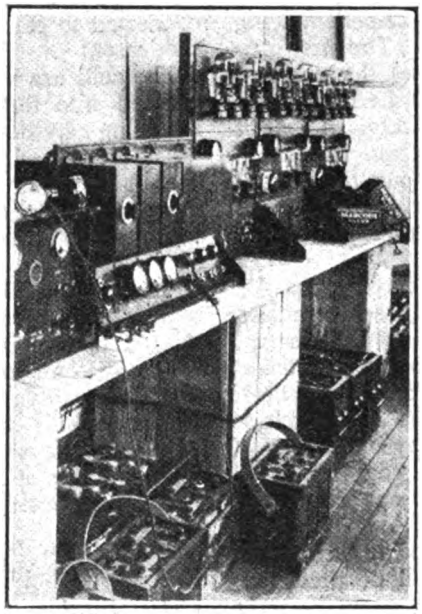
HAGUE WIRELESS CONFERENCE.

Practically every phase of modern radio will be discussed on the technical side at an international conference which opens at The Hague on Wednesday next, September 18th, and continues until October 2nd. It will be composed of members of the International Technical Consultative Committee of Radio Communications.



PUBLIC ADDRESS RECORD. One of the nineteen amplifying installations used by the Marconiphone Company to distribute the B.B.C. running commentary on the Schneider Trophy Race. Over 700 valves were used, together with 15 miles of wire.

The principal matter on which recommendations may be made will be that relating to wavelength distribution. Discussions will also take place on recent engineering advances, radio nomenclature, and the use of frequency control devices to limit interference.

RUMANIA'S RADIO SHOW.

The Bucharest International Wireless Exhibition, which opened last week, is continuing until September 20th.

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R.C.A.'S MILLION POUND PROFIT.

During the six months ended June 30th, 1929, the Radio Corporation of America showed a surplus profit of $4,996,487.

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COLUMBIA ENTER WIRELESS FIELD.

The Columbia Graphophone Company has decided to manufacture combined gramophones and radio receivers in this country on a large scale. The first sets may be on view at Olympia.

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POLYTECHNIC WIRELESS COURSES.

Evening courses in wireless and high-frequency engineering will begin on September 23rd at the Polytechnic, 307-311, Regent Street, London, W.1. The Polytechnic laboratories are equipped with modern apparatus and include a complete commercial installation for telegraphy and telephony (6RA). Enrolments begin on September 16th, and full particulars of the courses, which extend over a period of five years, can be obtained on application.

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FIRST RADIO SHOW IN NEW ZEALAND.

Five years ago there were only 3,000 licensed wireless sets in New Zealand. Now there are 44,000, according to a statement made by the Postmaster-General, Mr. J. B. Donald, at the recent opening of the first New Zealand Wireless Exhibition at Wellington Town Hall. The principal attractions of the Show, writes a correspondent, were the Post Office experimental laboratory and a studio from which programmes were broadcast through the local station, 2YA.

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NEW BATTERY COMBINATION.

We are informed that the two well-known makers of portable batteries, Pete and Radford, and the Hart Accumulator Co., Ltd., joined forces as from the 9th of September under the name of the National Accumulator Co., Ltd. The object is the development of sales of portable batteries, particularly for motor cars and wireless.

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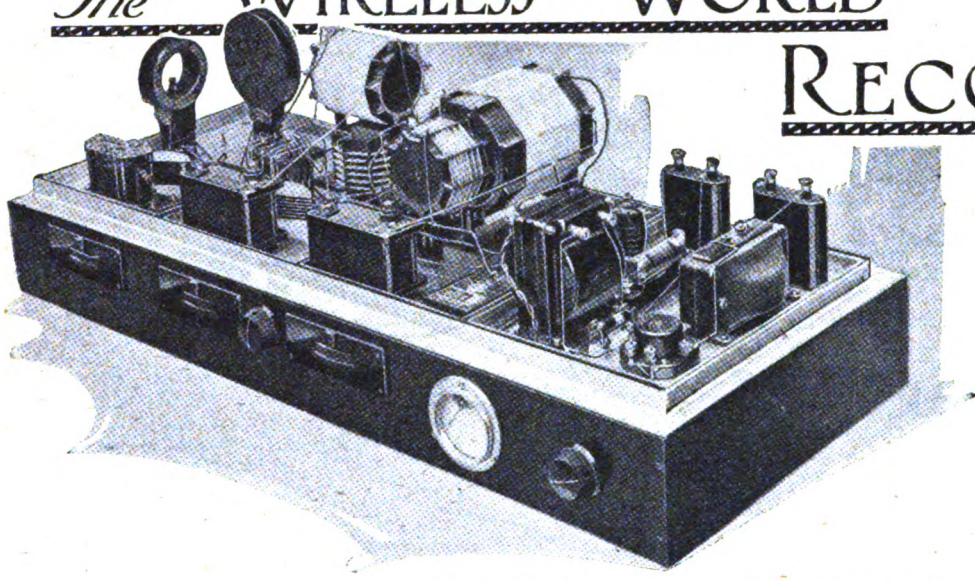
The WIRELESS WORLD RECORD III



Constructional Details and Final Adjustments.

(*Concluded from page 218 of last week's issue.*)

By A. L. M. SOWERBY, M.Sc., and H. F. SMITH.

AS was mentioned last week, it takes some 48 hours of soaking in spirit to soften the cement holding the base of a valve in position. The first step in construction will therefore be to stand the valve in spirit in order that it may be ready when required. Methylated spirit evaporates rather quickly, so that it will be necessary to fill up the vessel again from time to time during the period of soaking. Once the cement is thoroughly soft there is no danger whatever of damaging the valve if the base is withdrawn gently after cutting the connecting wires.

The remaining components that will have to be got ready before beginning to assemble the set comprise chiefly the tuning coils. It is not unlikely that manufacturers may offer these coils ready wound, but those who prefer to wind their own will find full practical information in the illustrations and the notes below them. The following additional notes may be useful:—

Medium-wave grid coil: Two or three coupling turns will be suitable for the average case; one turn will suffice if highest selectivity is required.

Long-wave grid coil: Four to six coupling turns provide normal coupling; two or three will be preferred by those living near 5XX.

Medium-wave transformer: An alternative construction is to wind the primary over the secondary, using ebonite spacers to keep the windings about $\frac{1}{16}$th inch apart. This entails less work, but makes a rather frail coil. Efficiency will not be impaired.

Long-wave transformer: Some practical hints on winding coils of this type will be found in the description of the "New Kilo-Mag. Four" (*The Wireless World*, August 14th and 21st). Note that one primary slot is outside the secondary, and that the 6-turn balancing coil is coupled to this section. In each case the balancing turns are wound in the same direction as the other windings on the former, the inner end being connected to earth and the outer end to the balancing condenser.

The coils are mounted with the help of wooden discs inserted into their ends. The remaining details of mounting may be gathered from the various illustrations.

The screen-grid valve, mounted below the base to keep it out of the field of the coils, is fixed to a bracket that carries its centre $1\frac{1}{2}$in. from the wood. The capacity screen shown is 3in. × 4in., exclusive of the turned-over rim that supports it, and has a $1\frac{5}{8}$in. hole at its centre. The valve-holder is that sold by the makers of the valve, and has five contacts; another of same pattern is used for the output valve.

The detector mounting shown in the diagram, in which the valve is held by rubber bands against a rubber pad, is an alternative to the metal clip seen in one of last week's photographs. The change was made because it was found that some AC/G valves tend to slip out from a clip owing to the shape of the glass bulb.

Reducing the Tuning Condenser Minima.

The Burndept condensers shown were specially selected for their very low minimum capacity, which is a point of considerable importance where the inductance of the coil is raised to the highest practicable value. Their minimum has been still further lowered by removing the metal screens supplied with them, as these are not needed when the receiver is completely screened. To help in keeping down the minimum capacity, the lead that runs through the base to the grid of the detector should pass through an oversize hole of not less than $\frac{1}{4}$in. diameter.

The balancing condenser, a Gambrell "Neutrovernia," is attached by its one-hole fixing bush to

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The Wireless World Record III.—

an odd piece of ebonite about 1½in. × 2in., and is mounted upside down, as shown, so that it can be adjusted from below the baseboard. A large clearance hole is cut in the screening to prevent a short-circuit of the balancing system.

Owing to the fact that it was found very essential to keep all high-frequency currents out of the low-frequency stage, a choke is placed between the anode of the detector and the primary of the transformer, while a 0.0005 mfd. condenser is connected directly from plate to cathode of the valve to "earth" the switches, which are fitted with slotted heads. Constructional details of these heads need hardly be given, as those who have the necessary tools will be able to design them for themselves, and it is anticipated that these heads, which will be applicable to almost any receiver, will shortly be marketed by the makers of the switches. The operating knob is left to the constructor's taste.

The rest of the constructional work, which, owing to the design of the screening box, is quite straightforward, needs no special comment, as it amounts to no more than fixing each component in the position prescribed in the detailed diagrams which accompany this article.

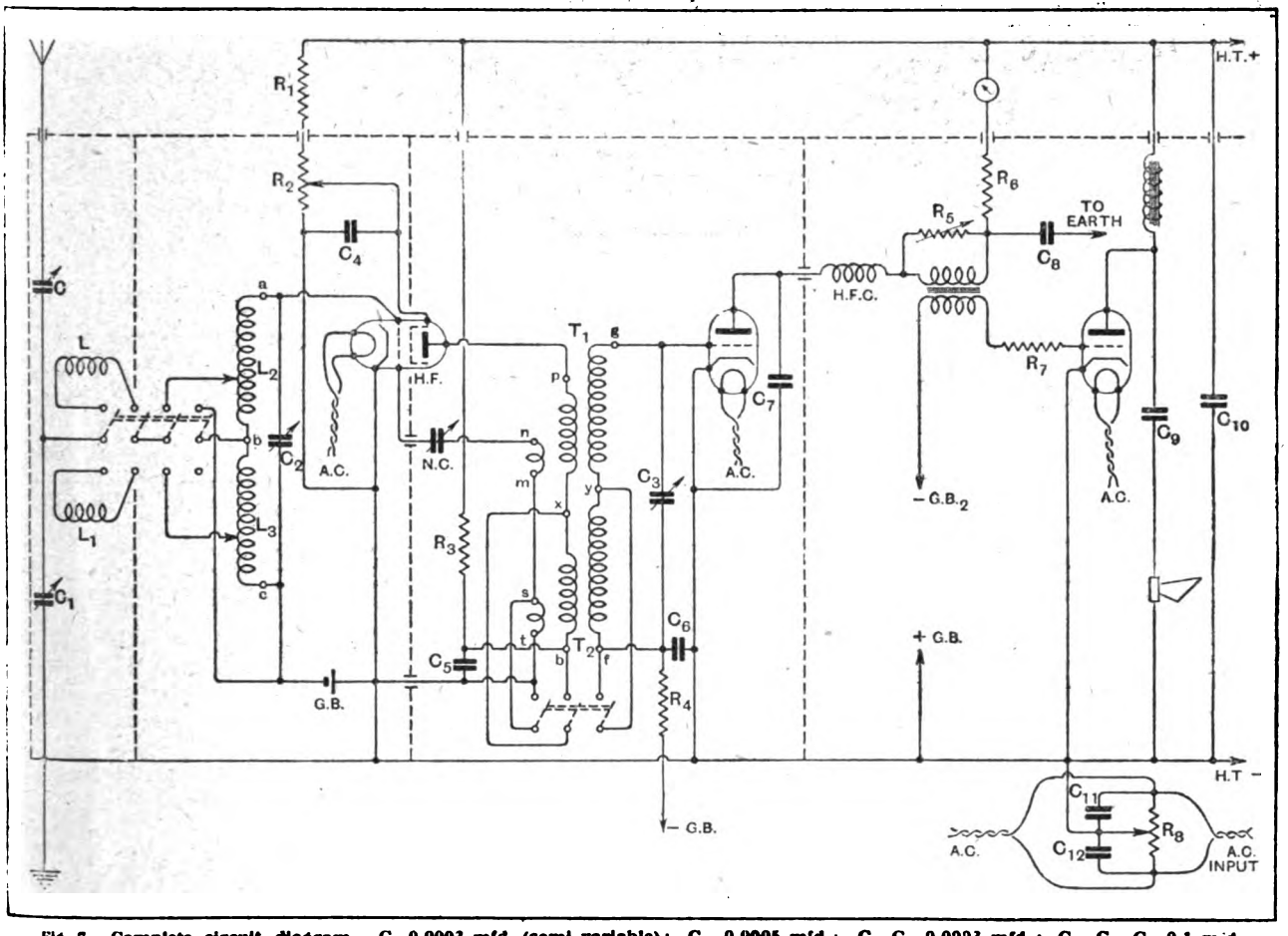

Fig. 7.—Complete circuit diagram. C_1, 0.0003 mfd. (semi-variable); C_2, 0.0005 mfd.; C_3, C_5, 0.0003 mfd.; C_4, C_8, C_9, 0.1 mfd.; C_7, 0.0005 mfd.; C_6, C_{10}, 2 mfds.; C_{11}, C_{12}, 0.005 mfd.; R_1, 10,000 ohms; R_2, 25,000-ohm potentiometer R_4, 600 ohms R_5, 0-200,000 ohms (variable); R_3, 20 000 ohms; R_7, 100,000 ohms; R_8, 400-ohm potentiometer.

high-frequency currents. In view of the presence of this condenser, it was thought advisable to remove the condenser which is incorporated across the primary of the AF5 transformer. This was done by removing the case on the primary side, and cutting through, with a hacksaw, the terminal block in which the condenser is embedded.

When these preparatory details have been attended to the work of assembly can begin in earnest. It will be well to begin by mounting the switches in position, and making up the simple "ganging" device shown. Standard strip brass is used for joining the handles of

There are a few points in connection with the wiring, however, to which attention must be drawn.

Although it is not immediately obvious from the diagrams, the principle of "Scientific Wiring" (see *The Wireless World*, April 25th, 1928) has been incorporated to a large extent, so that the run of the wires should follow the practical wiring diagram closely. In particular, care has been taken to connect all by-pass condensers direct to the cathode of the valve in whose plate or grid circuit they are placed, so that each high-frequency circuit is completely independent. To bring all earth returns indiscriminately to the nearest point

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The Wireless World Record III.—

of the screening is *not* a satisfactory substitute, and the writers disclaim any responsibility for the behaviour of a receiver in which the precautions described are not taken.

and cathode were at the same high-frequency potential. Logically, this double condenser bridge should be fitted to each valve separately, thus involving six such condensers in the set, but the less expensive expedient of using two condensers only, situated close to

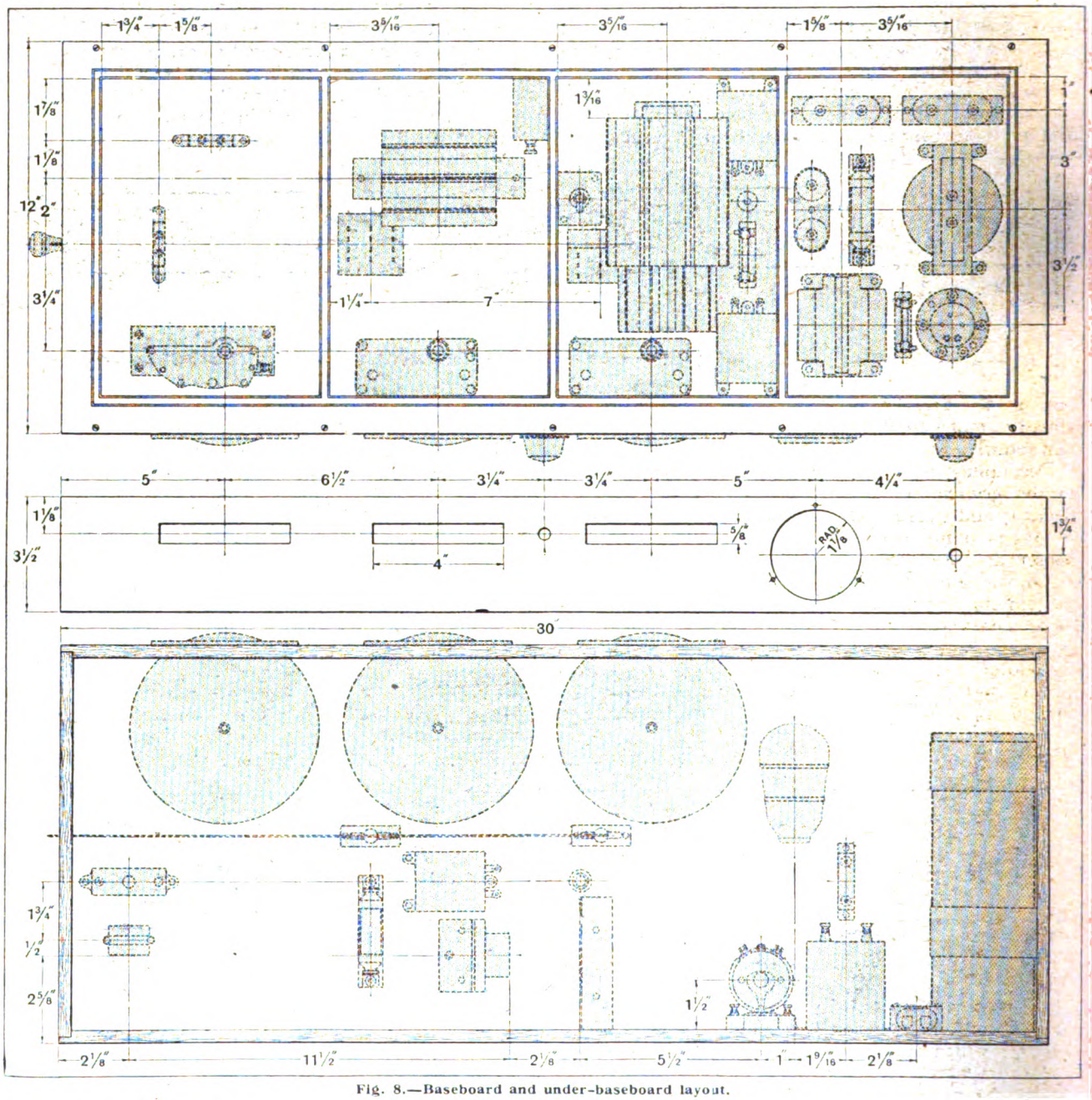

Fig. 8.—Baseboard and under-baseboard layout.

Indirectly heated valves require one precaution that does not enter with battery-heated valves; in the present receiver the cathodes are, as usual, connected to the slider of a potentiometer placed across the heater terminals. It was found necessary to join each end of this potentiometer to the slider by a condenser of 0.005 mfd. to ensure that heater the potentiometer below the baseboard, was found amply adequate. These condensers, which appear in the photographs and diagrams, are essential to the proper working of the set.

Apart from odd metal objects, such as the cases of the fixed condensers and the capacity-screen round the H.F. valve, connection is only made to the screening

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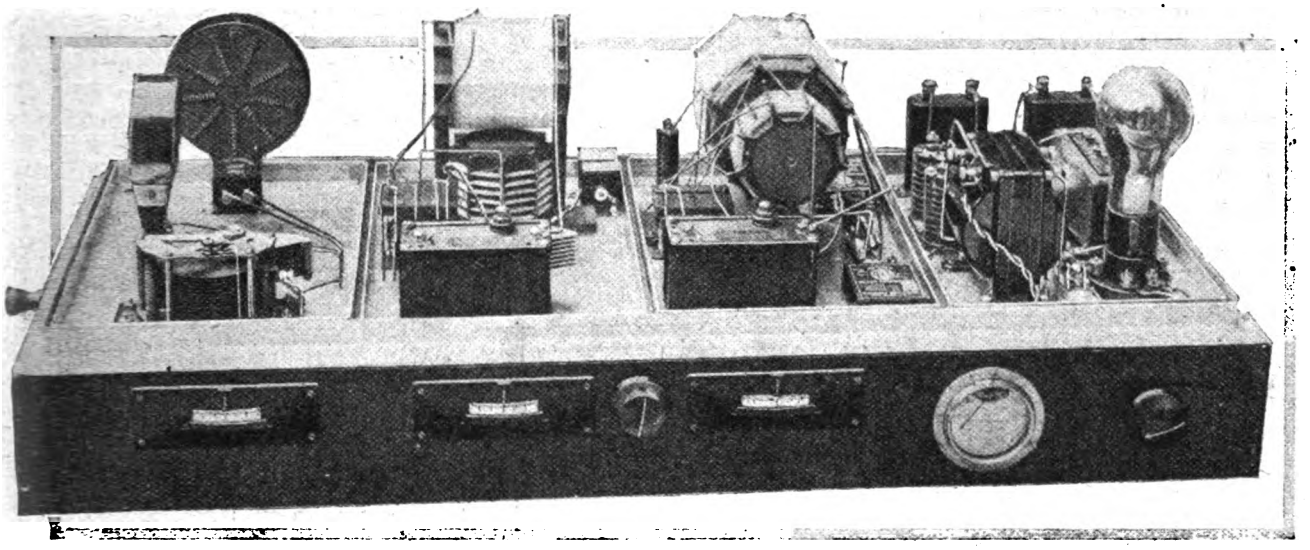


Front view of receiver without screening cover. The screens visible on the two Burndept condensers should be removed.

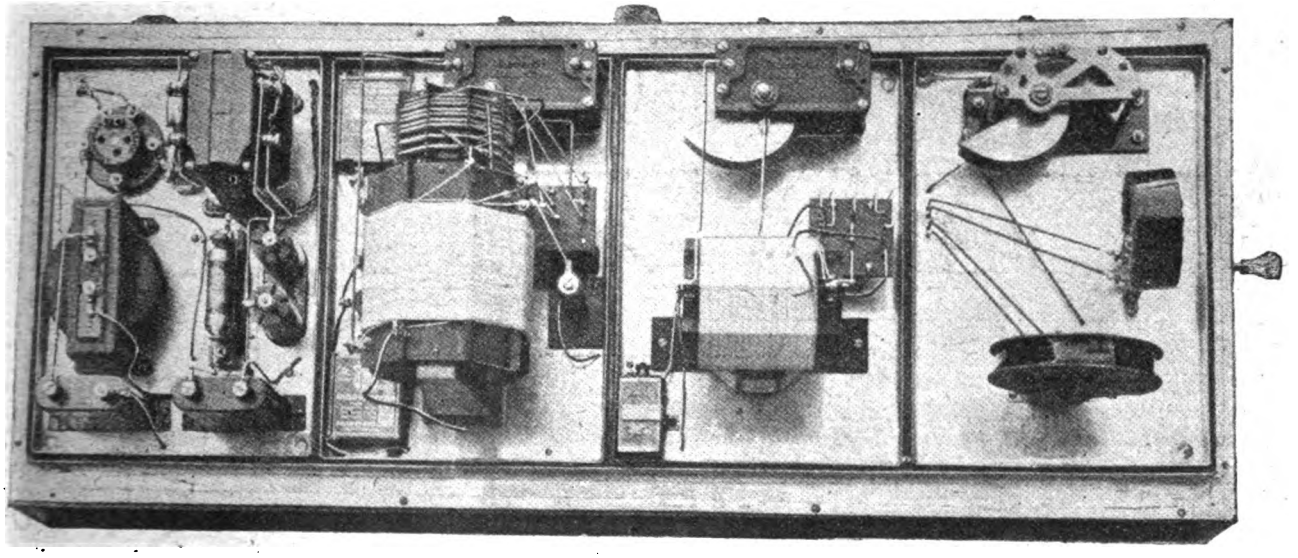
box by one wire from the cathodes of the valves. As already emphasised, the screens are *not* used as omnibus return leads.

Decoupling is fairly complete, being applied even to the grid-circuit of the detector, thus enabling the detector and output valve to share a grid-bias battery. A 10,000 ohm Loewe resistance and a 0.1 mfd. condenser are used here, while a wire-wound resistance of 20,000 ohms has been used for the plate circuit of the detector valve, where currents up to several milliamps. may flow, if only for a moment. There is a resistance of grid leak type in series with the grid of the output valve to help to keep high-frequency currents out of the loud speaker leads; 100,000 ohms is a suitable value here.

The potentiometer used to control the voltage applied to the screening-grid is of American origin, and has proved perfectly satisfactory. Those who prefer to use British components may like to note that Messrs. Oliver Pell Control, Ltd., have just issued a series of Varley potentiometers of similar type.

Operating Notes.

It is intended that both filament (heater) and anode currents should be drawn from A.C. mains. For this reason no switch is fitted to disconnect the screen-grid potentiometer, which, from batteries, would draw a continuous current. The receiver consumes about 25 to 30 milliamps. at 180 volts if a Cosmos AC/R is used as output valve; this will rise by about 10 milliamps. if a Cosmos AC/P1, which gives less amplification, though handling stronger signals, is substituted. Sufficient decoupling has been provided in the receiver itself to permit of the use of any eliminator, however



Plan view of receiver. The mounting of the balancing condenser is clearly shown.

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The Wireless World Record III.—

simple, that will provide the necessary current; this runs up the cost of the set, but it is only fair to remember that the eliminator is correspondingly cheapened.

Balancing is performed by setting the balancing condenser half-way between the two settings that give critical instability, the tuning condensers being preferably near the middle of their range. In the unlikely event of the same setting not giving stability on the long-wave range, the number of turns in the long-wave balancing coil may be altered suitably.

The standing current of the detector valve, when no signals are being received, should be about 0.4 milliamp. Signals should be tuned in accurately, using the deflection of the meter as a guide, and the screen-grid potentiometer should be used to adjust the detector current to about 1 milliamp. to ensure minimum distortion at this point. The output should be controlled independently by the second volume control.

It may be found that the wave-range of the aerial circuit is too high or too low to tune over the ranges of 240 to 600 and 900 to 2,000 metres covered by the other two tuned circuits. Using 60 and 200 turn coils, this fault may be remedied by adjustment of the semi-variable condenser in series with the aerial.

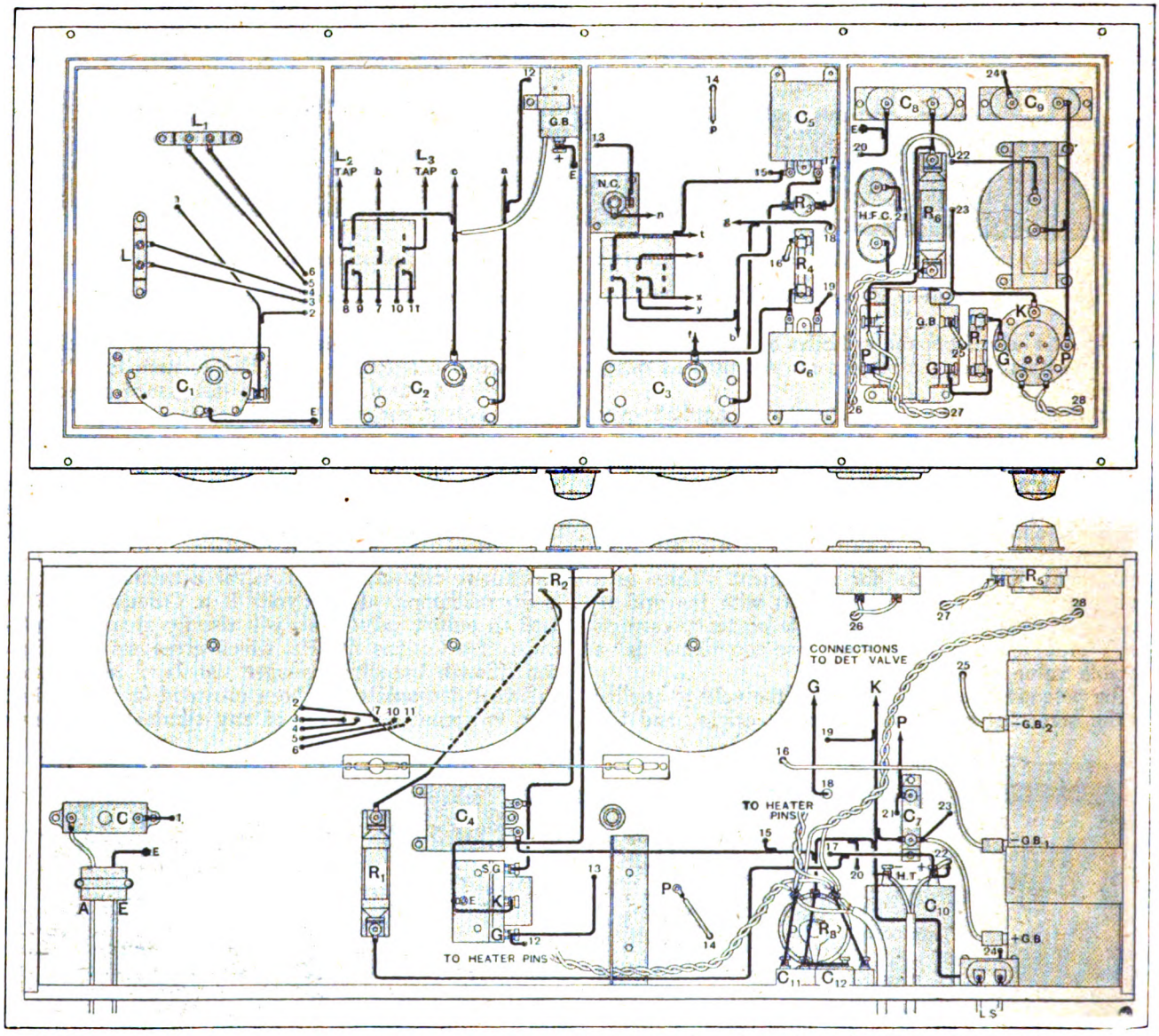

Fig. 9.—Practical wiring plan. The detector valve has been omitted from the plan underneath the baseboard, and the grid, plate and cathode connections have been marked G, P and K respectively. Earth points are indicated by E, and the lettering of the coil tappings corresponds with the lettering of Figs. 6 and 7.

In spite of its high amplification, this receiver is not intended to bring in American broadcasting stations, or quarter-kilowatt relays at the other end of Europe. It may, however, be relied upon, when used with any but the most inadequate aerial, to bring in every station of the slightest entertainment value at good loud speaker strength.

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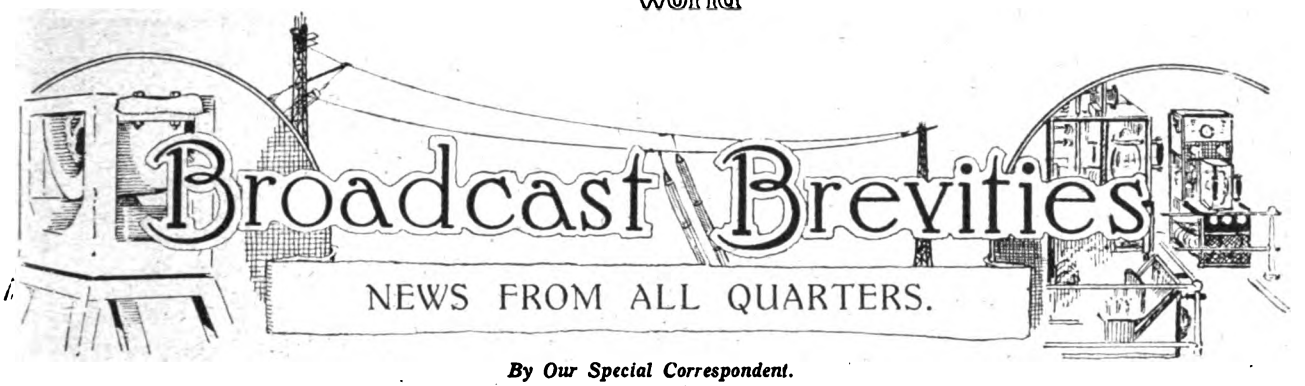


By Our Special Correspondent.

B.B.C. at the Show.—"Moorside Edge."—Crystal Users and Brookman's Park.

A Diorama at Olympia.

Not to be outdone by the enthusiasm and enterprise of the wireless trade at this month's Olympia Show, the B.B.C. promises its patrons an exhibition novelty in the form of a diorama. This, I gather, will be a kind of multi-dimensional panorama, in *papier mâché*, measuring 12ft. × 2ft. × 3ft., which will portray the story of a broadcast transmission from the studio, through the control room to the transmitter, and thence to the aerial and loud speaker of the listener.

Familiar to many visitors will be the small scale models of a typical studio and of a control room. And, of course, there will be a bookstall, without which no B.B.C. exhibit would be complete.

oooo

"Moorside Edge."

It was inevitable that controversy should flare up over the pronunciation of "Slaithwaite," and I am glad that the B.B.C has gracefully circumvented the difficulty by deciding that the site of the Northern Regional station shall be known as Moorside Edge. Whether or not there is geographical justification for the new name matters very little, since the B.B.C. has shown that it can be a law unto itself in terminological questions, thereby saving a good deal of bother.

oooo

Northern Regional Next Year.

The important point is that in all probability the agreements for the transfer of the property will have been completed by the time these lines appear, and that contracts for the constructional work are to be signed almost immediately. Preliminary work will begin before the end of this month, and it is confidently predicted that the Northern Regional station will be ready for operation within a year.

oooo

Crystal Users: New B.B.C. Policy.

Talking of Brookman's Park, I am interested to discover that the B.B.C. is at last taking steps to discourage crystal reception where the listener's purse will admit of the purchase of a single valve set. In the new B.B.C. pamphlet for crystal users in London area, the writers state that while no particular preference on the part of the B.B.C. for either crystal or valve sets is to be inferred, it is relevant to say that "in these days of low-voltage dull-emitter valves, the initial outlay for a one-valve set is but little more than a really good crystal set with an outside aerial, and the maintenance costs are very low."

Further, "the installation of a one-valve set with its own tuning unit, etc., is suggested in preference to any form of low-frequency amplifier as an addition to your present crystal set," the former being recommended, of course, as a more selective arrangement.

oooo

Auspicious Occasion.

In the "wee sma' hours" of Monday next Brookman's Park will send out the first scheduled transmissions under the regional scheme—a scheme which has been talked and written about for three years and more. Yet I am prepared to wager that before the week is out there will be indignant letters pouring into Savoy Hill from honest and respectable listeners who have "never heard tell" of such a villainous arrangement for cheating them of their rightful signal strength.

oooo

Women M.P.s at the Microphone.

The general layout of the B.B.C. Talks Programme for the remainder of the year shows little change. Seven o'clock remains the critics' hour, and the critics include, as before, Mr. Desmond MacCarthy and Miss V. Sackville-West, Mr. Ernest Newman and Mr. Francis Toye, Mr. James Agate and Mr. Basil Maine, who returns to the microphone after a spell of absence.

Adult education talks will be continued at 7.25 p.m. daily, while late evening talks will be given by those established favourites, Sir Walford Davies, Mr. Vernon Bartlett, and Mr. Gerald Barry.

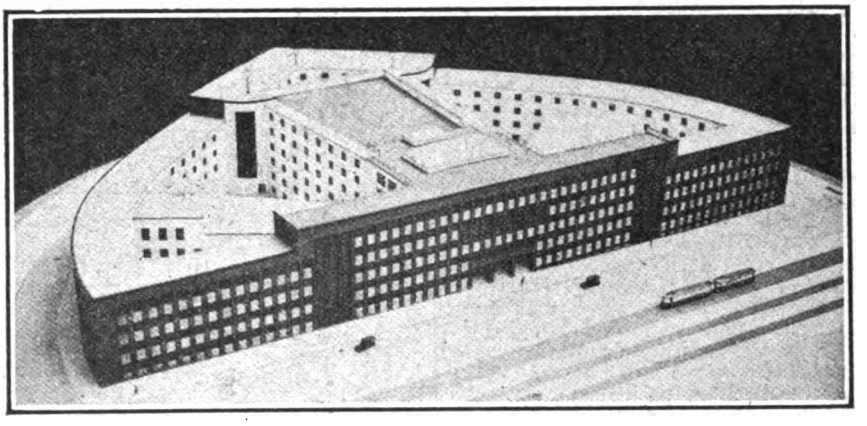
One of the most startling innovations will be a series of talks on Wednesday mornings entitled, "The Week in Parliament," to be given by women M.P.s.

oooo

2,000 Miles of Landline.

The Prime Minister's speech from Geneva entailed the use of 2,000 miles of landline—the longest cable link ever used in a B.B.C. transmission—with forty repeater stations. From Switzerland the speech was relayed to Berlin and thence to Brussels, and from there via the Post Office line to the La Panne-Thanet cable used in previous Belgian relays.

Although partially marred by extraneous noises, Mr. MacDonald's address was heard at times with astonishing clarity. That this was due, as one newspaper put it, to the fact that "the commanding voice of the Premier triumphed over the handicap of the forces of nature" is hardly fair to the engineers!



GERMANY'S "RADIO HOUSE." As becomes a new art, wireless is making its influence felt in the other arts with which it comes in contact, notably architecture. The picture shows a model of the new Radio House now under construction in Berlin.

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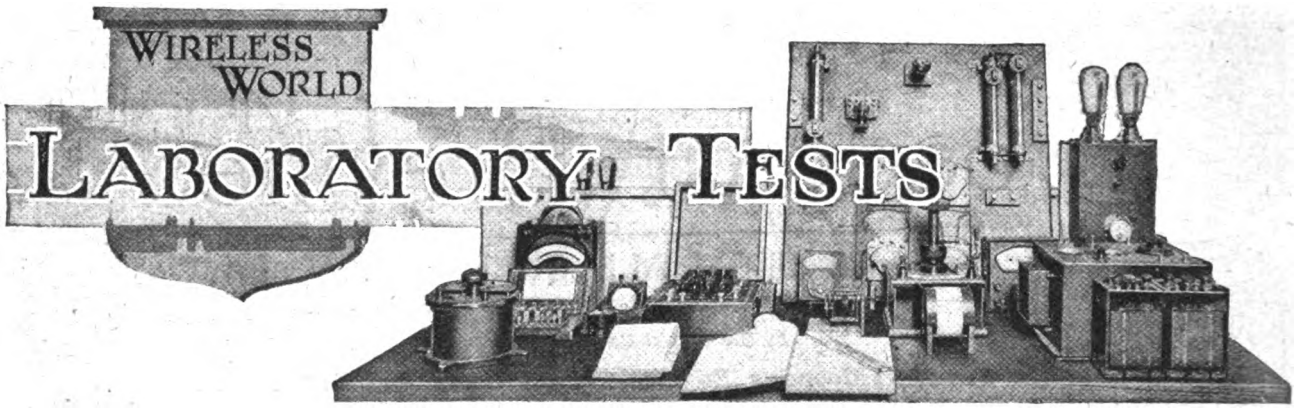
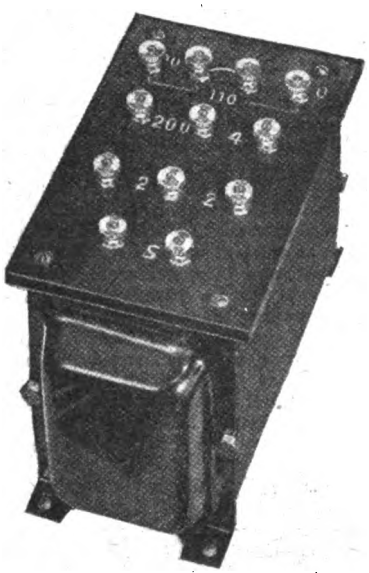


A Review of Manufacturers' Recent Products.

"ISO" MAINS TRANSFORMER.

In addition to a transformer carrying windings to give three output voltages, this unit incorporates also a smoothing choke rated to pass 25 mA. and maintain an inductance of 30 henrys.



"Iso" mains transformer with built-in smoothing choke. A half-wave rectifying valve can be used.

Half-wave rectification is allowed for, but since the filament supply for the valve—4 volts—is derived from a tapping on the 200-volt secondary winding, particular attention to the design of the eliminator will be necessary. A separate secondary winding, giving 4 volts and centre-tapped, is included for supplying the heater current to three indirectly heated cathode type valves.

The primary winding consists of two separate coils terminating at four terminals on the top of the unit. When used on a 220-volt supply main these should be connected in series, and for a 110-volt circuit a parallel arrangement is necessary.

Supplies are available from Messrs. Haw and Co., 20, Cheapside, London, E.C.2, and the price is 35s.

oooo

"PEP" DRY-CELL H.T. BATTERIES.

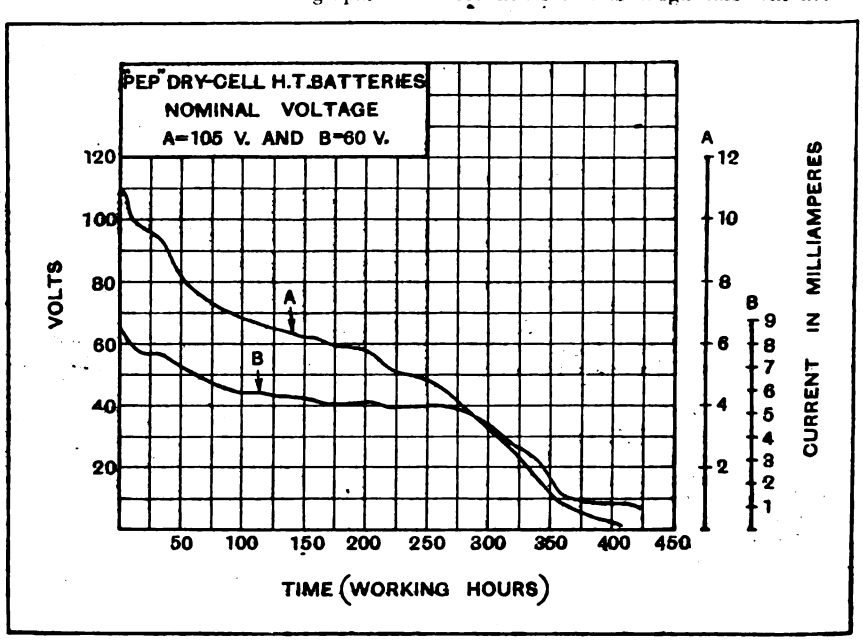
Two batteries, one 60 volts and the other 105 volts, nominal, were sent in for test and it was decided to commence the discharge at different rates for the purpose of computing the most economical discharge rate. Since both appeared to consist of the same size cells, this arrangement would be satisfactory in spite of the difference in voltage.

The 105-volt battery was started at 11 mA and the 60-volt type at just over 8 mA. The lower discharge rate would appear to be the more satisfactory since in this case the current was well maintained for a period of approximately 250 hours after the initial fall and when the steady state had been reached. This curve is marked "B" on the graph.

In the case of the higher discharge a less satisfactory performance is obtained,

"Pep" 105-volt dry-cell H.T. battery.

but it is significant that the natural "cut-off" coincides with that shown for the lower rate. This curve is given at "A" on the graph. The useful life of the samples tested can be taken as about 300 hours and although this will not be



Discharge curves of "Pep" H.T. batteries. "A" refers to the 105-volt size and "B" to the 60-volt unit.

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extended materially by keeping the current drawn from the battery down to about 8 mA, the voltage will be maintained at a steadier level during its useful life if this course is adopted.

These batteries are supplied by Messrs. R. Cadisch and Sons, 5 and 6, Red Lion Square, London, W.C.1, and the prices have been fixed at 12s. 11d. for the 105 volt size, and 7s. 11d. for the 60 volt unit.

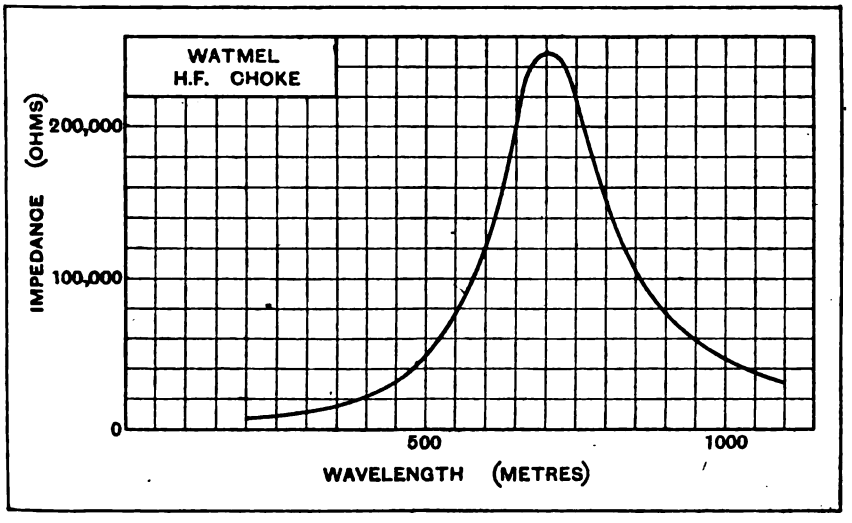
o o p o

WATMEL H.F. CHOKE.

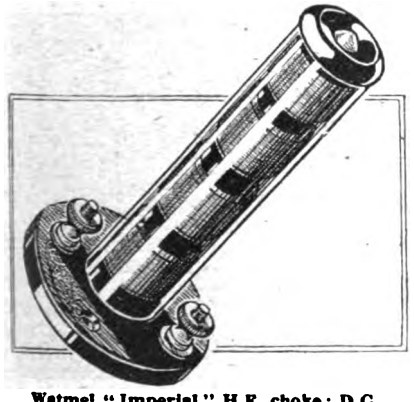
An ingenious system of winding is employed in the "Imperial" H.F. choke made by The Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware. The choke is wound in four sections on a long cylindrical former, and the turns in each section are cross-wound, the principle being reminiscent of the well-known duolateral bank winding employed in certain plug-in tuning coils. Double-silk-covered wire is used, and the coils are protected by a thick celluloid tube. Terminals are provided on the moulded base which is 2in. in diameter, the overall height is 3⅝in.

The D.C. resistance is 49 ohms, which would seem to indicate that the windings contain less than the usual quantity of wire. This supposition is confirmed by the impedance curve which shows that with an external capacity of 8 micro-mfds., resonance occurs at 700 metres, and in these circumstances self-oscillation might occur from 700 metres upwards if the choke were connected in the anode circuit of a valve associated with a tuned grid circuit. In practice the associated circuit capacity would exceed 8 micro-mfds., and it is possible that in these circumstances the choke would be free from self-oscillation up to the Daventry wavelength. The impedance values at certain selected wavelengths were as follows :—

Wavelength (metres).	Impedance (ohms).
200	6,600
500	48,000
Resonance	248,000



Impedance curve of Watmel H.F. choke; external capacity 8 micro-mfds.



Watmel "Imperial" H.F. choke; D.C. resistance 49 ohms.

Another specimen choke submitted for test attained resonance at 750 metres, and had an impedance at this wavelength of 256,000 ohms, which shows that the constants of the choke are repeated with fair accuracy in manufacture. The price of the Watmel "Imperial" choke is 5s.

o o o o

READY RADIO PRODUCTS.

Among the items sent in for test was a "selectivity unit" which an examination proved to be a rejector and as such should be extremely useful as an aid to distant reception under the shadow of a near-by broadcast station. The design is such that it can be connected to most sets without alteration to the internal wiring, all necessary connections being made external to the receiver. A practical test made with the aid of an unselective receiver and situated within 1¾ miles of 2LO enabled signals, hitherto receivable only during the quiescent periods, to be tuned-in during broadcast hours. It was noticed, however, that the presence of the unit somewhat impaired the sensitivity of the set, but the loss in sensitivity is compensated for in ample measure by the increase in the number of stations receivable.

"Ready Radio" selectivity unit.

This particular model is for use on the 250 to 600 metre waveband, and is offered at 20s.

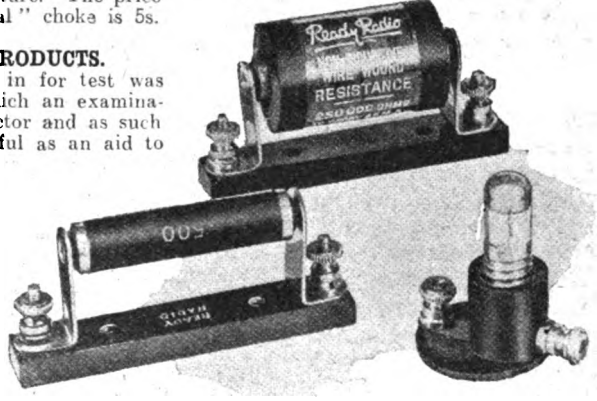
Some samples of cartridge-type wire-wound resistances ranging from 500 ohms to 250,000 ohms were tested; the measured values were as follows :

Nominal Resistance.	Measured Value.	Percentage Error.
250,000 ohms.	247,000 ohms.	−1.2%
10,000 ,,	9,850 ,,	−1.5%
2,500 ,,	2,550 ,,	+ 2%
1,000 ,,	1,066 ,,	+6.6%
500 ,,	489 ,,	−2.2%

Prices of these are as follows :—

200,000 and 250,000 ohms, 8s. 6d.; 10,000 ohms, 6s. 6d.; 2,500 ohms, 4s. 6d.; 1,000 and 500 ohms, 2s. 9d. The base is included in this price.

The same firm have marketed an H.T. safety fuse which sells complete for 1s. 6d.



"Ready Radio" wire-wound resistances and H.T. safety fuse.

Tests show that the average fusing current of the samples examined is between 170 and 180 mA. The makers are Ready Radio, 159, Borough High Street, London Bridge, London, S.E.1.

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IMPROVING the FRAME AERIAL

A New Method of Eliminating Local Interference.

A FRAME aerial in combination with a good high-frequency amplifier undoubtedly offers the best means for eliminating the local station in favour of transmissions from a distance. If, however, a high degree of amplification is used, it becomes uncomfortably apparent that even at the minimum setting of the frame the local station does not disappear nearly so completely as theory would lead us to expect. There are various possible reasons for this annoying phenomenon, of which one may be a lack of symmetry in the frame. This can be caused by objects, especially those of a metallic kind, in the neighbourhood of the frame, but the trouble can be avoided fairly easily by careful construction and by ensuring that the frame occupies a suitable position in the room. Another common obstacle to the complete elimination of the local station in the minimum position is the "aerial effect" of the frame itself, which, by acting as a small elevated aerial, picks up a second supply of high-frequency energy in addition to that collected in its capacity as a pure frame. The true frame collects energy only from the magnetic lines of force in the received waves, whereas the aerial effect is due, as in the case of the ordinary outside aerial, to the lines of electric force.

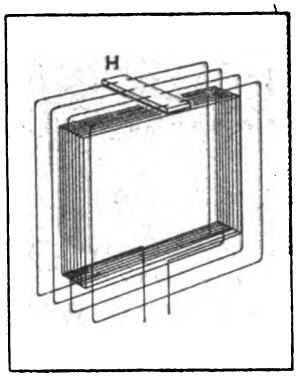

Fig. 1.—A diagrammatic view showing the screen of parallel copper wires which effectually prevents the lines of electric force from influencing the frame when in the "minimum" position.

Recently the experiment has been tried of introducing an electrostatic screen to protect the frame from the electric field while permitting the passage of the magnetic. Shielding arrangements of this kind have been used previously in connection with direction-finders using frame aerials. On attempting to use a similar degree of screening for the frame in broadcast reception, M. von Ardenne found that the screen introduced considerable losses. When, for example, the frame was enclosed within a box of sheet metal, cut through at one place to avoid producing a shorted turn which would absorb the magnetic lines as well as the electric, it was found that the high-frequency resistance of the frame was very considerably increased. However, the beneficial effect of the screen in permitting the local station to be completely, or nearly completely, cut out was very marked. Another solution that suggested itself, but which also led to heavy losses in the frame, consisted in enclosing the frame in a wooden box lined inside with thin sheet aluminium with, as before, a gap in the metal at one point.

A Frame Aerial Screen.

It was finally found that the best all-round type of shielding, having practically no effect on distant reception, but removing the "aerial effect" completely, consisted of a screen of parallel copper wires, as shown diagrammatically in Fig. 1. Outside the frame winding, parallel to it, and at a distance of about 3cm. are wound about half as many turns as those in the frame itself. The continuity of these turns is broken at one point, the piece of ebonite H serving as support for the wire. A finished frame aerial of this design is shown on the left in Fig. 2, while the large frame on the right shows an older arrangement for the reception of longer waves. The wooden frame carries both the aerial and its electrostatic screen. The pieces of insulating material used at the break in the screening-wires are shown in Fig. 3.

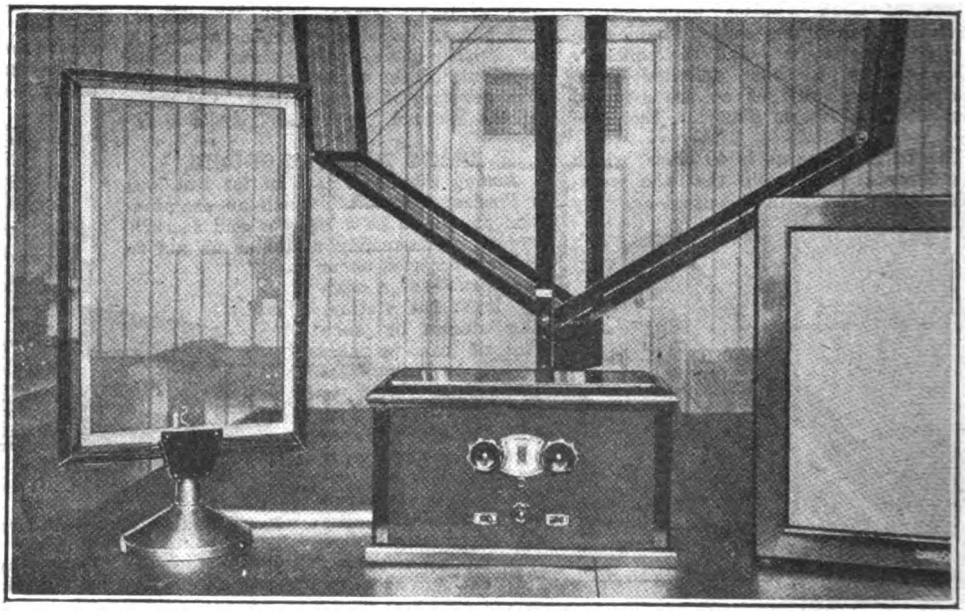

Fig. 2.—The frame aerial on the left has been made to the specification described in this article. In addition to the copper wire screen surrounding the aerial, note the metallic casing enclosing the leads to the receiver.

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Improving the Frame Aerial.—

It is not enough, however, to screen the frame alone; the leads to the receiver must also be surrounded with a metallic casing, in some such manner as that to be seen in the title illustration. This metal screen round the leads is in electrical connection on one side with the screening wires of the frame, and on the other with the screening-boxes containing the receiver and amplifier.

The value of such an arrangement of screens is not limited to its ability to cut out the local station; the arrangement makes it possible to employ the directional effect of the frame aerial for minimising interference from such sources as electric trams and high-frequency apparatus. It has been found that in most cases interference of this type is quite definitely directional, so that while it can be only partially eliminated with an ordinary frame, the screened frame is completely effective in the majority of cases.

Some interesting observations can be made with a frame of this type used in conjunction with a good amplifier. It has been found that while the carrier of the local station can be completely cut out, single side-bands, especially at dusk, apparently arrive from quite a different direction, so that signals from the local station reappear, though in a peculiarly distorted form.

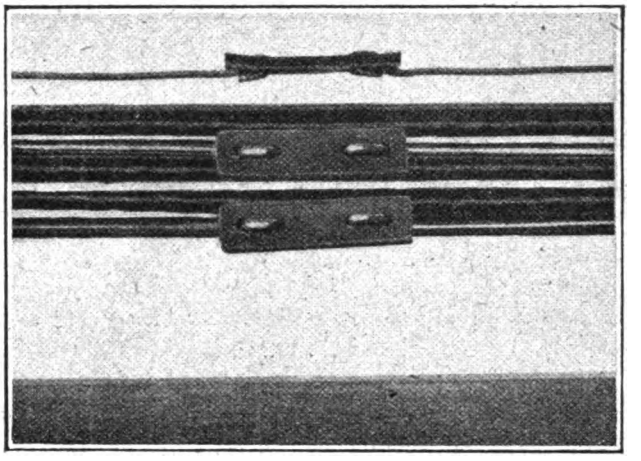

Fig. 3.—A "close-up" of a portion of the frame aerial showing the insulating material used at the break in the screening wires.

Fortunately, this phenomenon occurs but seldom, and as a rule lasts only for a short time.

In general the screened frame offers a considerable improvement, especially in cities, in the reception of distant stations.

USEFUL DATA CHARTS. No. 27(a) and 27(b).

Stage Gain with (1) H.F. Transformer: (2) Tuned Anode Circuit.

WHEN a coil and tuning condenser are arranged in parallel in the plate circuit, the circuit when on tune behaves as a pure resistance R whose magnitude is given by

$$R = \frac{\text{square of coil reactance}}{\text{coil resistance.}}$$

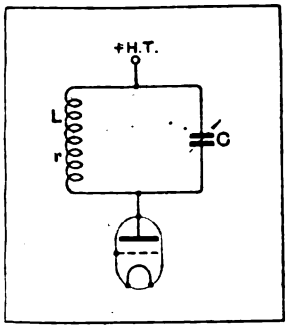

Fig. 1.—When the circuit is tuned to the incoming frequency the coil reactance $2\pi f.L$ equals the condenser reactance $1/2\pi f.C$ and the plate load is equivalent to a pure resistance $2\pi f.L \times \frac{2\pi f.L}{r}$ = coil or condenser reactance × coil amplification.

As explained in Fig. 1, R is also given by the formula R = condenser reactance × coil amplification. Thus at 300 metres with the condenser set to tune at 0.0003 mfd. the condenser reactance is 531 ohms (by Chart 8) and the coil amplification may be expected to be 150 under working conditions if solid wire is used. Hence the equivalent parallel resistance is $531 \times 150 = 80{,}000$ ohms. Fig. 2 shows the equivalent circuit; m is the voltage amplification of the valve and R_1 is its differential resistance. We find that the stage gain is $mx^2/(1+x^2)$, where

$$x^2 = R/R_1 = \frac{\text{condenser reactance} \times \text{coil amplification}}{\text{valve resistance}}$$

The corresponding result for a H.F. transformer using the optimum step-up is shown in Fig. 3 and the corresponding stage gain is $mx/2$.

Accordingly we can easily calculate the stage gain once x is known and the efficiency of the H.F. transformer with best turns ratio can be compared with that of the tuned anode circuit. It is interesting to note that x is roughly the ratio of the secondary to the primary turns in the H.F. transformer; as explained in Chart 26, the actual ratio is usually about 10 per cent. less than the value of x, due to imperfect coupling between the coils.

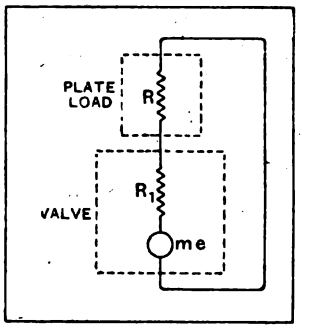

Fig. 2.—When the plate load is replaced by its equivalent pure resistance R and the valve by a resistance R_1 with an e.m.f. me, the stage gain is $mR/(R+R_1) = mx^2/(1+x^2)$ where $x^2 = R/R_1$.

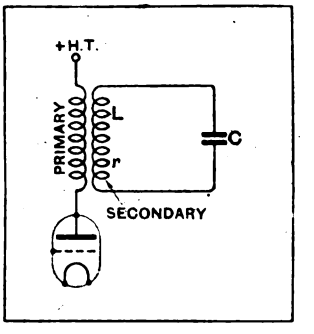

Fig. 3.—When the tuned circuit is used as the secondary of a H.F. transformer and the primary turns have been found by Chart 26 the stage gain is $mx/2$ where x has the same meaning as in Fig. 2.

(Continued on page 256.)

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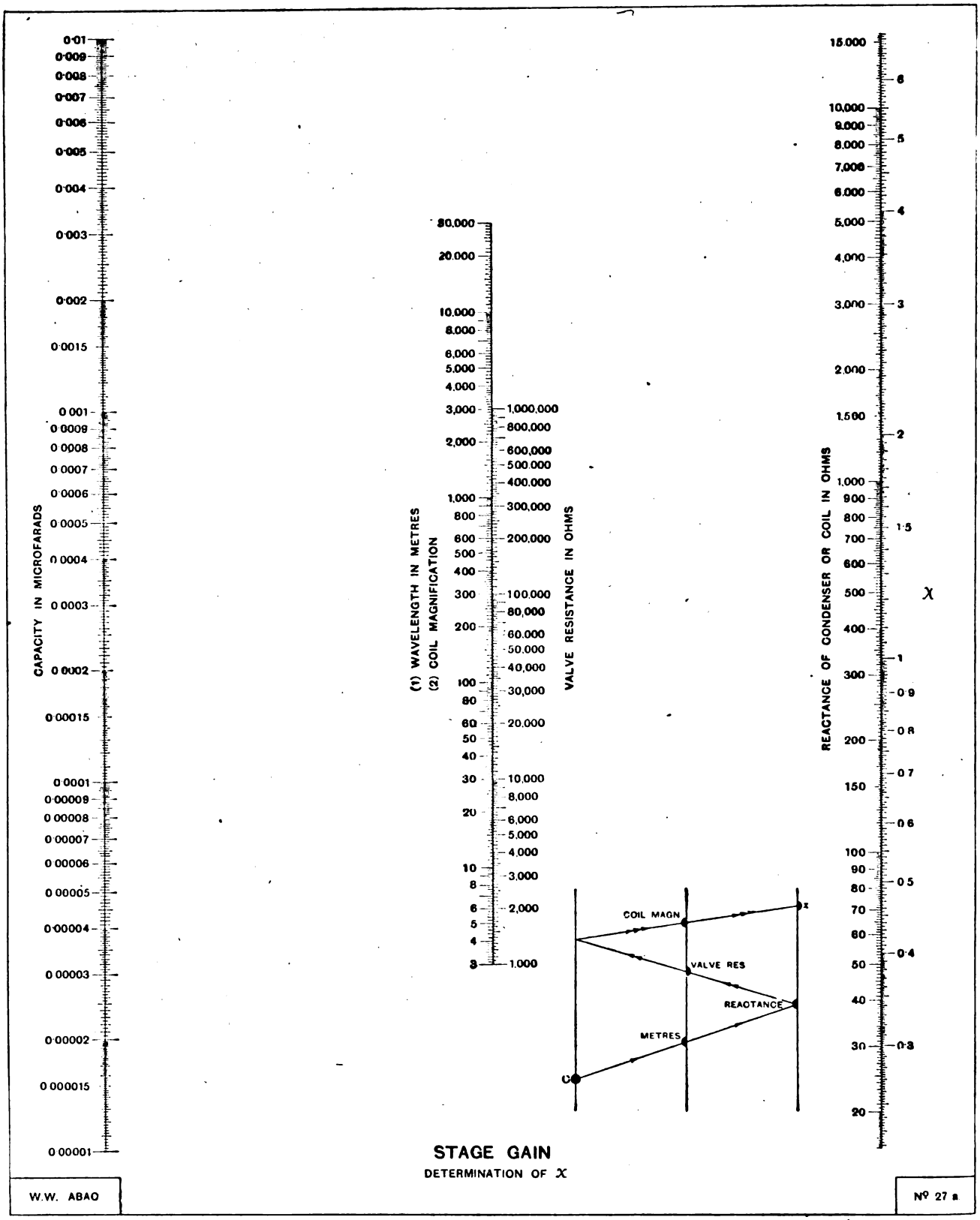

STAGE GAIN

DETERMINATION OF X

W.W. ABAQ

Nº 27 a

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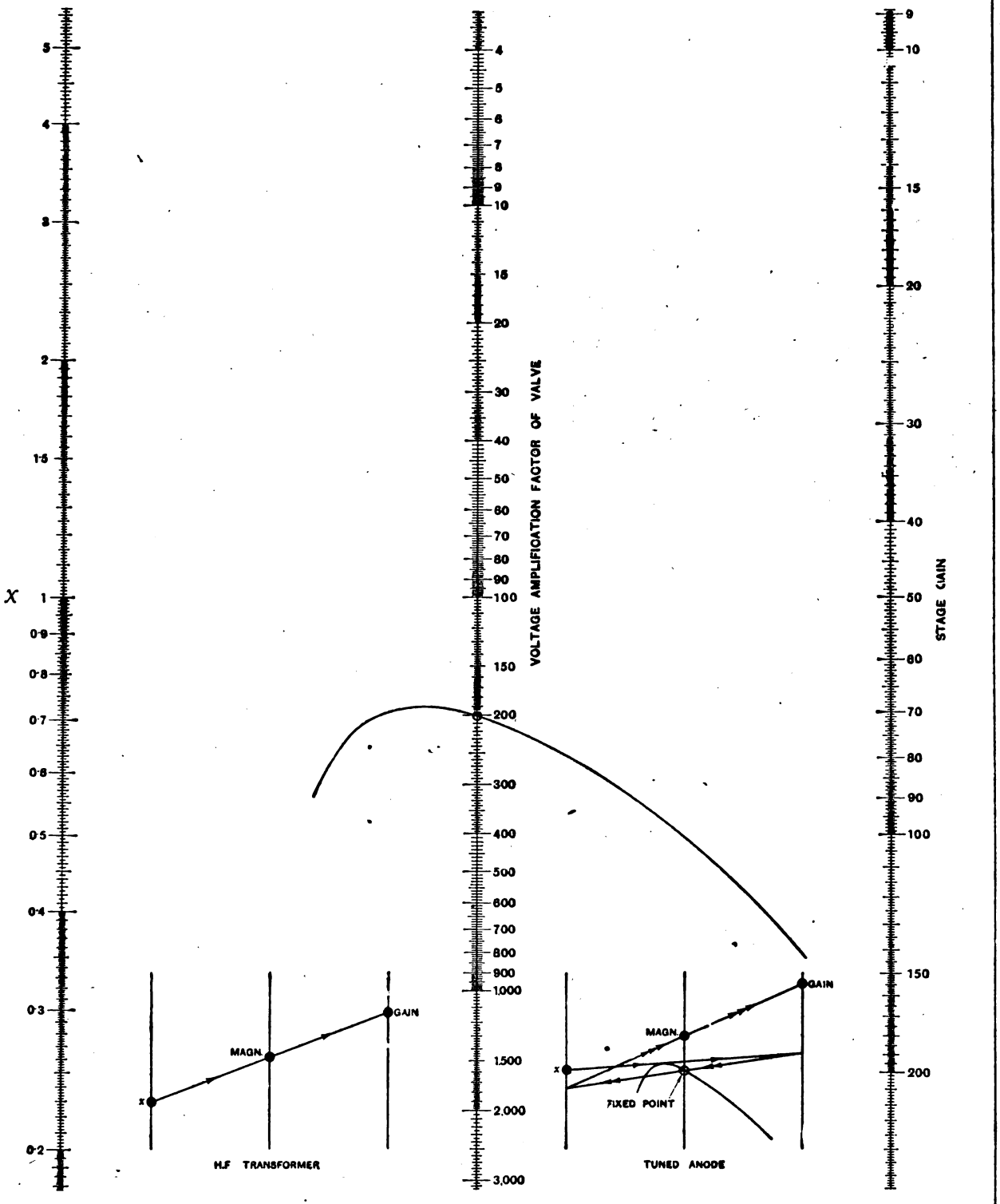

STAGE GAIN WITH (1) H.F. TRANSFORMER (2) TUNED ANODE

W.W A8A0

Nº 27.b

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Useful Data Charts. No. 27(a) and 27(b).—

The stage gain here calculated does not take into account reaction effects due to internal coupling of the grid and plate circuits through the grid-plate capacity of the valve; we are only considering conditions well removed from instability.

Chart 27(a).

This chart enables us to find x. Thus with a condenser tuning to 300 metres at 0.0003 mfd. and an 80,000-ohm valve, the coil magnification being 150, we find $x=1$. Again, if we set at 0.0015 mfd. for 150 metres and use a 40,000-ohm valve, with a Litz-wound coil whose magnification is 300, we find $x=2$.

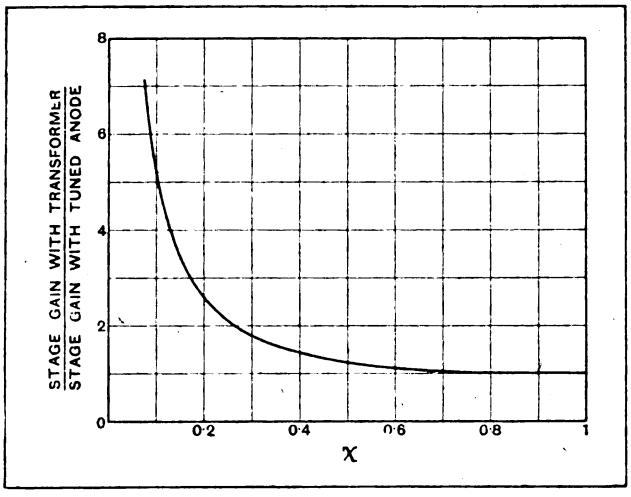

Fig. 4.—The relative merits of tuned transformer and tuned anode can be seen from this graph.

Chart 27(b)

We can now find the stage gain. If the voltage amplification of the valve is 100 and $x=1$, then on using a H.F. transformer the stage gain is 50 according to this chart; if a tuned anode system is used instead, the stage gain turns out to be exactly the same. This only occurs for $x=1$, while for any other value the H.F. transformer gives the bigger stage gain.

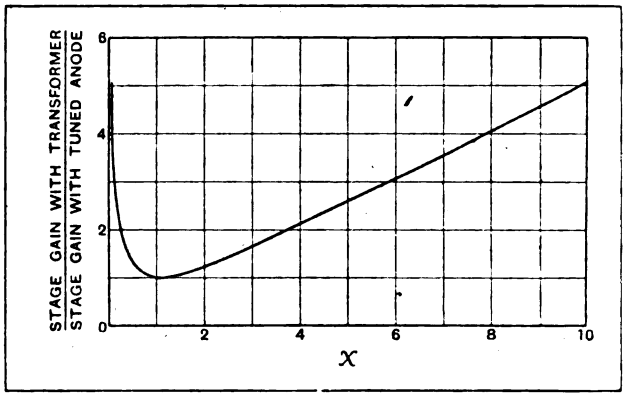

Fig. 5.—Further comparative figures for tuned transformer versus tuned anode.

Thus when $x=0.4$ and the same valve is used ($m=100$), the stage gain is 20 with the H.F. transformer and only 13.8 with the tuned anode circuit.

Figs. 4 and 5 show the stage gain with transformer relative to that with tuned anode for different values of x.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

EMPIRE BROADCASTING.

Sir,—I have studied your correspondence columns during the past few months, and apparently the subject of Empire broadcasting is still provoking considerable discussion, while it is obvious, judging by criticisms, that little progress has been made.

As one who did a certain amount of pioneer work in this direction, I realise that private enterprise, in any shape or form in connection with Empire broadcasting, will not receive any official support in this country. I carried on my experimental transmissions for over twelve months, with only one breakdown, and it was unanimously agreed that the quality and nature of the programmes left nothing to be desired. From hundreds of letters and cables I received from every part of the world, the appreciation was more than I ever expected, and I have since received signed petitions urging me to carry on.

When the Washington wavelengths came into force, my wavelength had to be changed, and only a very limited licence was offered me; therefore, I did not consider I was justified in going to the expense which the change would have incurred.

The bone of contention amongst our scattered Empire is that nothing is provided during the week-end when naturally listeners have the most time for listening-in to the Old Country, and I am still anxious and willing to carry on, on a suitable wavelength, concentrating on week-end transmissions, at my own expense, not that I have the slightest commercial interest in wireless, but simply out of amateur enthusiasm in order to fill the gap which, it seems to me, is not filled by those whose duty it is to fill it.

The Post Office have always shown a sympathetic interest in my endeavours, and possibly with the present change of Government, the vested interests may also show some enthusiasm in my proposal. In conclusion, 2 NM has been dismantled and is now being rebuilt in a more favourable location, and could be ready to start in two months' time.

GERALD MARCUSE.
President, Radio Society of Gt. Britain,
Vice-President, International Radio Relay League.

London, E.C.3.

G5SW—THE "EMPIRE STATION."

Sir,—We have had a change of Government, and it quite possible this might meet the eye of someone who will be responsible for the vagaries of the B.B.C. Empire Short Wave station, which apparently is still hiding behind its experimental cloak. Looking through the many letters which have appeared in your journal from time to time, one can deduce the following complaints, really indictments, against G5SW:—

(1) Its callousness to public opinion.

(2) Its failure to come out into the open and tell us the truth about the results of its broadcasts, except on exceptional occasions.

(3) Its total disregard of transmission hours to suit an Empire to the East of the Greenwich Longitude.

(4) Its lack of propaganda and even prevision.

(5) The exclusion of the news items from its programmes.

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(6) Its deliberate closing down on Saturdays and Sundays, when its programmes could be best appreciated.

To begin with, this fact must be realised, that for some time now the Dutch transmissions starting at about 1 p.m. G.M.T., broadcast and telephony, are regularly heard at *loud speaker strength* on three valves, even at this the hottest season of the year in India, while the luncheon broadcast, scarcely half an hour earlier, is dumb, even to its carrier wave, on G5SW.

We have to wait till close on midnight before the regular London programme at seven o'clock starts with many a hiatus and wait; and sometimes, if we tune in a little late and find no carrier, we give it up as hopeless, though it might have been a period of waiting. Comparisons are odious, but, geographically, Chelmsford is 200 miles across the sea from Huisen and 200 miles on short waves is nothing, probably only a fraction of the "skip" distance.

Again, on whose behalf are these lines written? They are for the Planter and people living in remote places, or also on behalf of 50,000 British troops scattered far and wide from Cairo to Singapore and Hong Kong, who would gladly form themselves into wireless clubs if they were certain that G5SW would function at some reasonable hour for four or five days in the week. No one requires a Home connection more than the British soldier in the East, and no one would appreciate a boom of this kind more than he; but do not deprive him of the local news (news which the cables never worry about, and such sports items as he is keen on, and which would not deprive the newspapers of any really first-hand news). Besides, it has been proved that news broadcast whets the appetite for further details.

People in England never hear G5SW except as a ground wave, so there does not appear to be any necessity to "beam" and flirt with Los Angeles, Illinois, etc., when we in India, for instance, have broadcast stations 500 miles away, 50 per cent. Oriental music, and eight out of the twelve months mush and Xs. The want is felt here, not in the U.S.A. This, therefore, is the position:—

(1) The short wave is the only medium of any certainty for Empire receptions. The wavelength should be well clear of any beam station and as low down as possible; 20 metres is suggested.

(2) That from 1 p.m. G.M.T. selections from the programmes of 2LO and 5GB, or other relay, should be broadcast, and such should be continuous. As a trial, "beaming" might be tried, Canada and the West Indies coming last, being "with the sun." I may note that PCJ broadcasting to Mexico and South America is clearly received here; in fact, it does not seem to matter much in which direction PCJ twists its "Antenna" (why not aerial?), if it has got such a thing.

(3) That such transmissions should be on at least five days in the week, and to include Saturdays and Sundays. I have suggested in a previous paragraph that they should be continuous or that the carrier wave should be in evidence all the time.

(4) News items and sporting news should be included, and any special event should be relayed. A time signal would be most useful.

RADIOX.

India.

"THE GLUT IN THE ETHER."

Sir,—I should like to make some comments in regard to the article, "The Glut in the Ether," in *The Wireless World* of August 21st.

In reality, the percentage of listeners in Holland is much higher than 1.7—at least 3, although still higher, in my opinion—but, as we do not have to take out licences, and as most people, even dealers, do not know that we must advise the Postal Authorities, no verification of this figure is possible. The percentage given by your journal is that of the Postal Authorities.

The German figure, and, perhaps, for the same reason, the British also, is much inflated owing to the many crystal sets in use in those countries.

Why the French need such a number of stations is a riddle to me. If I am to believe their papers, the most popular sets have at least four valves (Isodyne), while most sets seem to have even more.

For what reason, then, should other listening communities suffer under such old-fashioned conditions, as with three valves alternative programmes are available everywhere, and two valves are enough in most places?

Any suggestion that Great Britain and Germany should have the first pick of wavelength, as they were first in the field, is wrong. On this basis Holland should have the very first pick and Germany only come in at the third or fourth place.

Amsterdam. TH. A. KAMMINGA BRUYN.

Sir,—May I be permitted to comment upon the question of "The Glut in the Ether"? From the standpoint of a Polander, I am compelled to explain why we have only 0.7 per cent. of inhabitants who are officially interested in radio programmes.

The greater part of our country was devastated during the world war. For this reason, the population is very poor. Public duties and modest living claim all the salary which one earns. I am sure, however, that the population is at least 100 per cent. more interested in radio than the official records show.

The writer of the article maintains that the number of transmitters should be reduced. I agree with him, but the reduction must be executed proportionately by each country on the basis of the Prague scheme. M. S. MARCINKOWSKI.

Warsaw.

AMATEUR STATUS.

Sir,—Your recent leading articles, and subsequent correspondence, on the subject of amateur status urge me to register a very strong protest against the flow of criticism poured out against the Radio Society of Great Britain. That Society, of which I am proud to be a member, is in an unenviable position, like the B.B.C., because it has to cater for people of widely diverging mentality, and, as is the case the world over, the very few grousers always gain a far bigger hearing than the huge majority of well-satisfied persons who are in possession of the true facts, and who stop to think before rushing into print with their grievances.

The R.S.G.B. is accused, most unjustly, of not gaining for the amateur facilities which the authorities have very definitely refused to grant, and you yourself must realise this.

Mr. Kemp complains of the treatment meted out to his Society, the A.B.R.S., by the Postmaster-General, in connection with what really seemed like a direct infringement of the monopoly granted to the B.B.C. I would point out to him that the treatment they received was only such that any amateur would have expected had he attempted the same thing.

With regard to the question as to which is the premier amateur society in this country, the fact that the R.S.G.B. was responsible for (1) the issue of 23- and 45-metre permits to amateurs, (2) the issue of 32-metre permits to competent persons, (3) the issue of permits to use higher power than 10 watts, (4) the issue of 80-metre permits to a properly organised group, (5) the establishment of a "free to all" QSL card service, (6) the organisation of transoceanic tests, which paved the way for the world-wide communication we enjoy to-day, (7) assisting the Postmaster-General to frame the new regulations laid down by the Washington Conference, leaves not the slightest doubt as to which is the only society in this country worth considering.

Wanstead, London. LAWRENCE FULLER.

OLDEST RADIO SOCIETY.

Sir,—The subject of amateur organisation is of great interest to us in Ireland, so I have closely followed the discussion of the subject in your columns. We may get some useful hints from the constitution of any national amateur organisation that may finally be evolved.

Just now, however, a little point of interest has cropped up in a letter in your issue of the 21st inst. from Mr. Ashton J. Cooper. He suggests that the R.S.G.B. is the oldest wireless society in the world.

Some Dublin wireless men claim that The Wireless Society of Ireland, through one of its parents, The Dublin Wireless Club, is the oldest society. It should be easy to settle the question. I have looked up the old minute books of The Wireless Club, and find that the inaugural meeting took place on June 17, 1913. I see that a letter from The Derby Wireless Club was read at a meeting on July 14th, 1913.

When was The London Wireless Society founded?

DESMOND McATEER,
Hon Sec., Wireless Soc. of Ireland.

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READERS' PROBLEMS

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Poor Reaction Control.

My set is a fairly conventional arrangement of a single H.F. amplifier, anode bend detector, and two resistance-coupled L.F. stages. Condenser reaction control (applied from the anode circuit of the detector to the H.F. transformer secondary) is by no means satisfactory, and, indeed, at the upper end of the tuning scale it is impossible to bring about self-oscillation. Fortunately, sensitivity is quite good, even without reaction, but I should like to improve matters if possible, and would welcome any suggestion.

P. A. N.

It is a fact that reaction is seldom a great success in a receiver such as you describe, and it will be observed that it is not included in the majority of *Wireless World* sets of this type. We advise you to reduce your detector anode resistance to the lowest value giving adequate magnification, and to increase the associated by-pass condenser to the highest value consistent with the retention of high notes. It is wise to arrange matters in your reaction control circuit so that a large condenser—and consequently a small coil—is used.

Detector grid bias should be set rather below than above the value needed for best rectification, and its adjustment should be carefully made.

o o o o

Frame Aerial Details.

Although it is realised that the "Flat Dwellers' A.C. Three," can be used with any type of frame aerial, I should like to copy the design illustrated in the published description as closely as possible, as it would match my containing cabinet. Will you please supplement the details given in the article with a sketch showing the various dimensions and method of construction?

G. B. A.

We think that a consideration of Fig. 1, in conjunction with the published photographs, will make clear the method of construction employed. It will be evident that the windings are divided into two parts in order to afford a clearance for the central supporting rod.

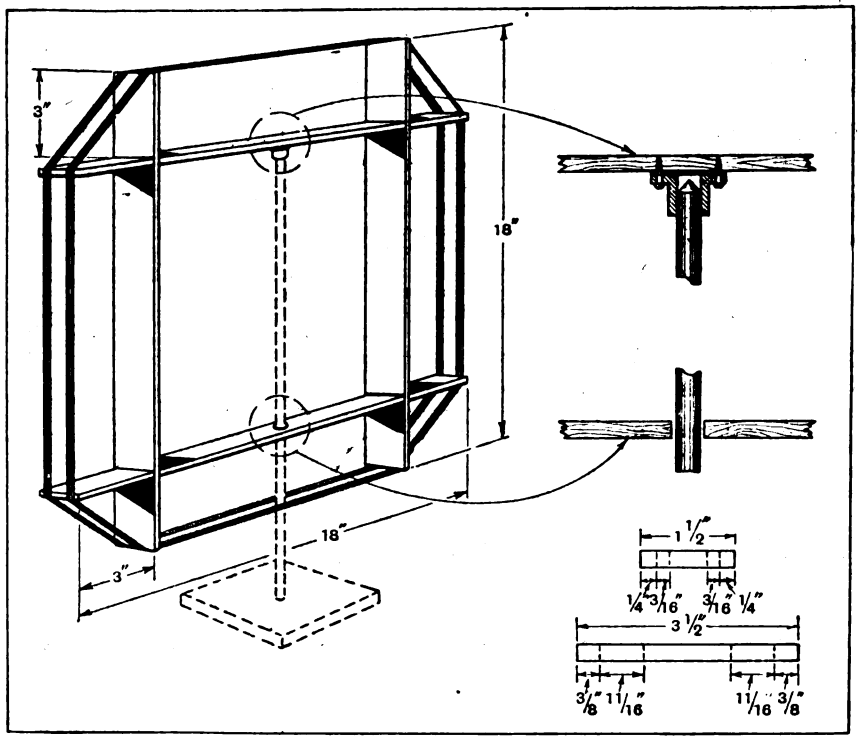

Fig. 1.—Constructional details of "Flat Dwellers' Three" frame. Particulars of the windings for long and short waves were given in the original article.

o o o o

Too Many Volts.

I have made a three-valve H.F.-det.-L.F. set with anode bend detection on the general lines embodied in several sets described in "The Wireless World." The receiver works quite well, but its sensitivity seems to be capable of improvement. I have noticed that when the H.T. plug feeding the detector valve is removed from its socket, signal strength momentarily increases to a very marked extent, and then gradually fades to inaudibility. Does this convey a suggestion to you as to what may be wrong?

L. V. F.

The symptoms you describe would suggest fairly definitely that negative grid bias for the detector valve is insufficient, having regard to the H.T. voltage applied; when you remove the H.T. plug the valve will, of course, be fed from the charge accumulated in the reservoir by-pass condenser included in this circuit, and the observed increase in signal strength will doubtless coincide with the moment when the voltage charge has dropped to a value suitable for the grid bias applied.

We recommend you to pay special attention to the setting of detector bias. As previously pointed out in these pages, this adjustment can best be effected when listening to very weak signals.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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OUR EXHIBITION FORECAST.

AS year by year the Radio Exhibitions succeed one another it is noticeable that each Exhibition has some outstanding feature which perhaps we may describe as a phase in development. Last year might well have been termed a screen-grid valve year, and the Show preceding that undoubtedly served to emphasise the popularity of the moving-coil loud speaker, and, in fact, at every Exhibition we find that some particular phase has been especially prominent.

What, then, is going to be the predominant note to mark the stage to which the design of broadcast receiving apparatus has reached as indicated by the Olympia Show this year? It is a difficult matter to form a conclusive opinion without all the facts necessary to guide one in coming to a decision, and at this stage in advance of the Exhibition it is probable that a good deal of information is still withheld which will not be available until the doors of Olympia open, but, judging from data which has reached the offices of *The Wireless World* up till now, we would say that 1930 is to be an "all-electric" year, battery sets being replaced by receivers working direct from the mains wherever electric light is available. The provision of apparatus within the set to replace batteries must, of necessity, add something to the cost, but it probably is a trifle when compared with the advantages which are gained and the saving in battery replacements and trouble.

Next in order of importance in forecasting the tendency of design must be mentioned that manufacturers have devoted special attention to a consideration of the need for increasing the selectivity of the most popular sets in order to make them applicable for use under the Regional Scheme.

The Three Valve Set as Standard.

A third observation is that whereas last year the sets to which designers had paid the greatest attention were those incorporating four valves, this year, with the improvement in valve efficiency and the consequent ability to obtain greater high-frequency amplification, the three-valve receiver appears to be gaining the position of being regarded as standard; in fact, a very large number of outstanding sets of this season will be found to correspond closely to the specification adopted by *The Wireless World* last season in the receiver known as the "Megavox Three."

We anticipate that in the coming year there is likely to be an enormous increase in the number of valve sets in use, partly on account of the simplicity of the modern receiver operating from the mains proving an attraction to those who could not be bothered with battery sets, but more especially because the next few months will undoubtedly see the almost total eclipse of the crystal receiver. Under the Regional Scheme we have contended that crystal sets will no longer be serviceable, except in particular areas. There will, therefore, be a big demand for simple valve sets, and the Exhibition this year will undoubtedly cater admirably for this class of user, and there is ample evidence that two- and three-valve receivers of simple construction will be available to the public at prices which a year ago would have been considered impossible. But it is not for us to say at this stage what will be the best products at Olympia; the ballot which *The Wireless World* has arranged again this year provides the solution to this problem, and we would urge every reader to make it a personal duty to vote, so that we may be certain that the decisions on what is best in every class of exhibit at Olympia is truly representative of the views of our readers

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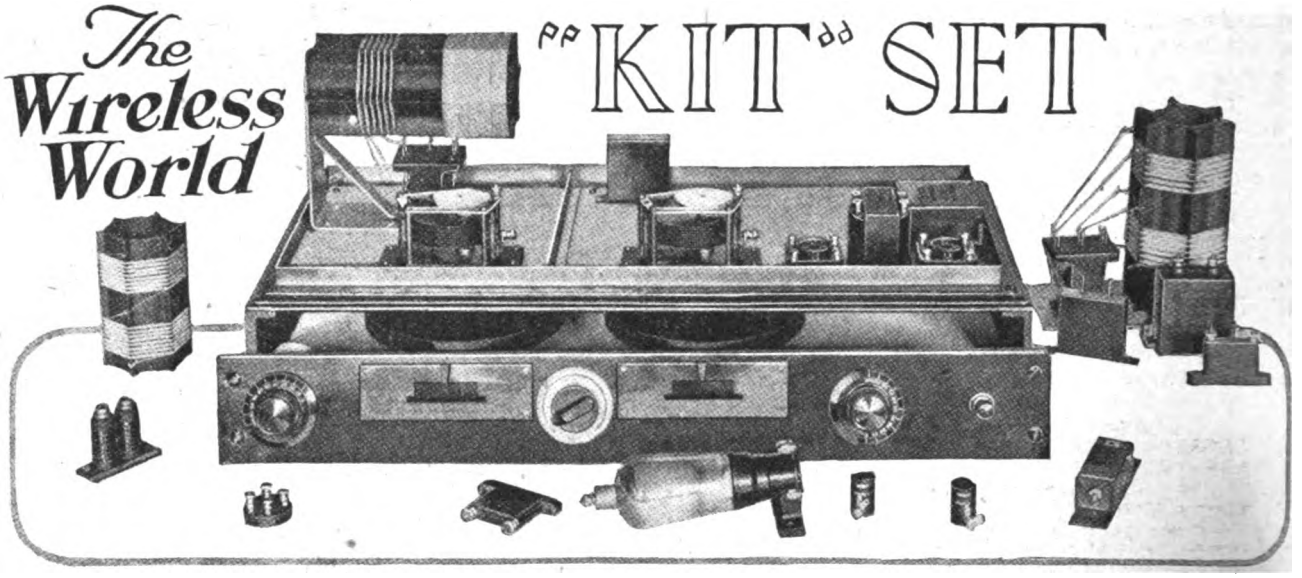

An Easily Constructed Three-valve Receiver of High Selectivity.

THE "kit" set is now so familiar an object of daily life that it requires no introduction or definition as far as *Wireless World* readers are concerned. Its popularity was originally established owing to the simplicity of construction and assembly, but it has other qualities which are frequently overlooked, or at all events insufficiently appreciated. Not the least important contribution made by the kit set to the art of broadcast reception has been to demonstrate that the requirements of the average broadcast listener can be satisfied by a simple three-valve set of compact dimensions. The results obtainable with the best types of kit set at present on the market are excellent both as regards range and quality, and there must be many

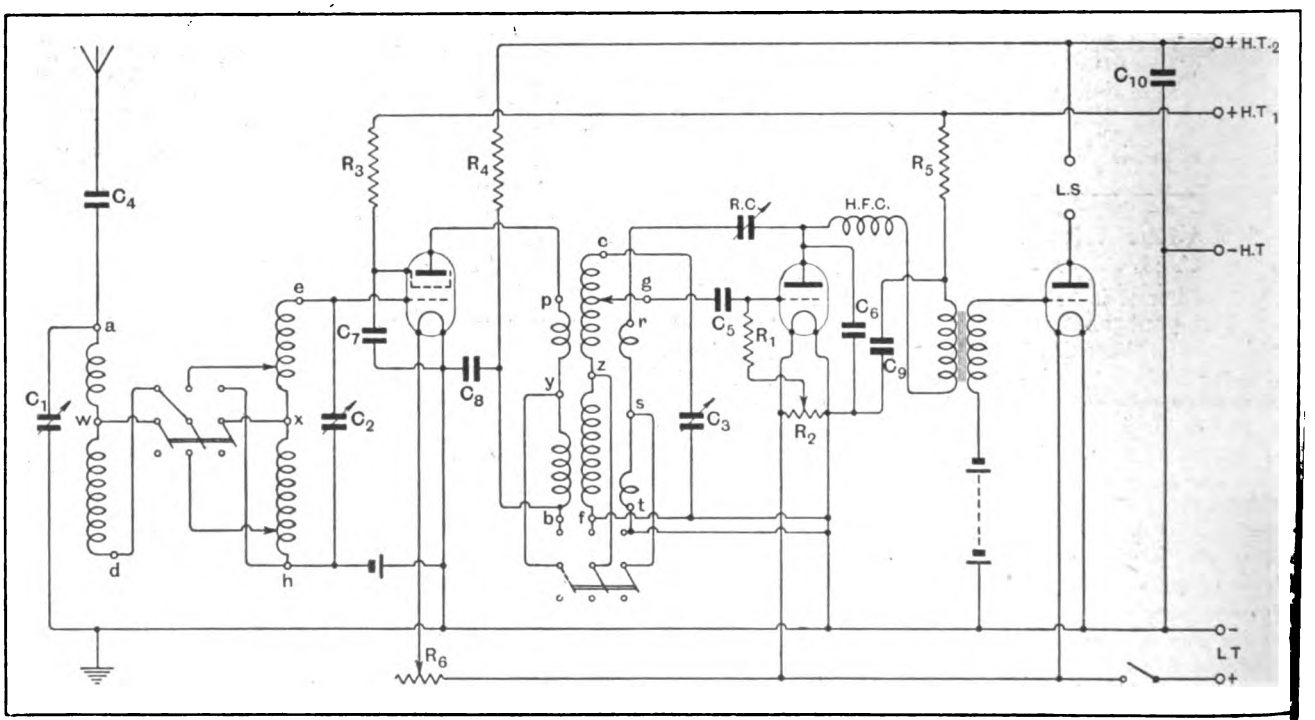

Fig. 1.—Complete circuit diagram. C_1, 0.0005 mfd.; C_2, C_3, 0.0003 mfd.; C_4, 0.0002 mfd.; C_5, 0.0003 mfd.; C_6, 0.0001 mfd.; C_7, C_9, 0.1 mfd.; C_8, C_{10}, 2 mfds.; R_1, 2 megohms; R_2, semi-variable potentiometer, not less than 400 ohms; R_3, R_4, 600 ohms; R_5, 20,000 ohms; R_6, 50-ohm rheostat. The coil connections are lettered to correspond with Figs. 2 and 4.

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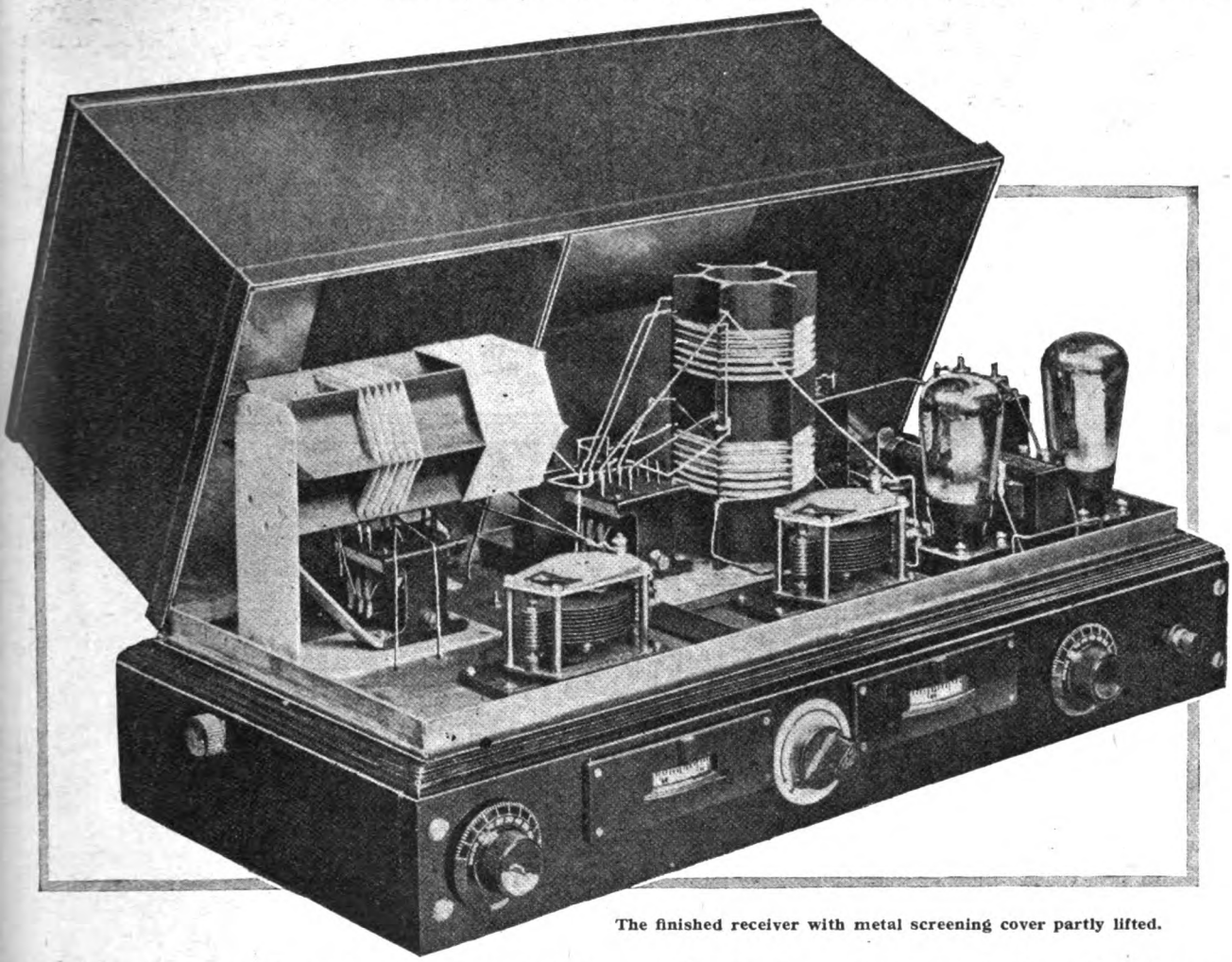
The Wireless World "Kit" Set.—

thousands of listeners, nay, millions if we are to accept the makers' figures, who have served their apprenticeship to wireless receiver construction in this way.

To this large class of reader *The Wireless World* "Kit" Set should make a special appeal. It has been built in the new type of metal cabinet described in recent issues with the result that constructional difficulties have been reduced to a minimum. But the chief merit and justification of the set is that it incorporates the best practice in tuning circuit and H.F. transformer design as proved in such sets as the "New Kilo-Mag Four." The result is a kit set which may be relied on to produce



The finished receiver with metal screening cover partly lifted.

something out of the ordinary in range and selectivity without departing from the essential qualities of compactness and simplicity. The cost of the complete set with the exception of valves, batteries and loud speaker should be between £10 and £12, depending on the quality of the components chosen.

Reference to the circuit diagram of Fig. 1 shows that a coupled aerial circuit, involving an extra tuning control, has been introduced. We are reluctant to add this complication to the usual kit set circuit, but, in our judgment, it is a measure which will be duly appreciated by those who build the set when the transmission of alternative programmes commences from the new regional stations. Even under present conditions the improved selectivity is essential if full use is to be made of the range and sensitivity of modern H.F. valves.

In designing the tuning coils and H.F. transformer the constants have been chosen to give the maximum H.F. amplification, having regard to manufacturing difficulties and the fact that the set will be called upon to function with all types of screen-grid valves. Incidentally it may be mentioned that a coupled aerial circuit is not without its compensations, for the secondary or grid circuit can be made to give a useful voltage amplification for a given energy in the aerial if the coils are well designed.

The screen-grid valve H.F. circuit is designed on well tried lines, and a filament rheostat has been introduced as a volume control. A considerable improvement in the characteristics of the valve under working conditions has been made possible by the introduction by Messrs. Siemens Bros. and Co., Ltd., of a special grid cell with a potential of 0.9 volt; most screen-grid valves are overbiased by the standard 1½-volt grid cell.

The detector functions on the leaky grid principle

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The Wireless World "Kit" Set.—

which gives greater sensitivity to weak signals than anode bend, and also permits the use of an inexpensive L.F. transformer. The grid circuit of the detector is connected across two-thirds of the short-wave secondary winding in order to reduce damping. To introduce a

be explained in greater detail in next week's issue. Reaction is applied to the H.F. transformer so that there is little fear of radiation if the set oscillates, the screen-grid valve with its low interelectrode capacity acting as an effective barrier to H.F. oscillations generated by the detector. The by-pass condenser C_6

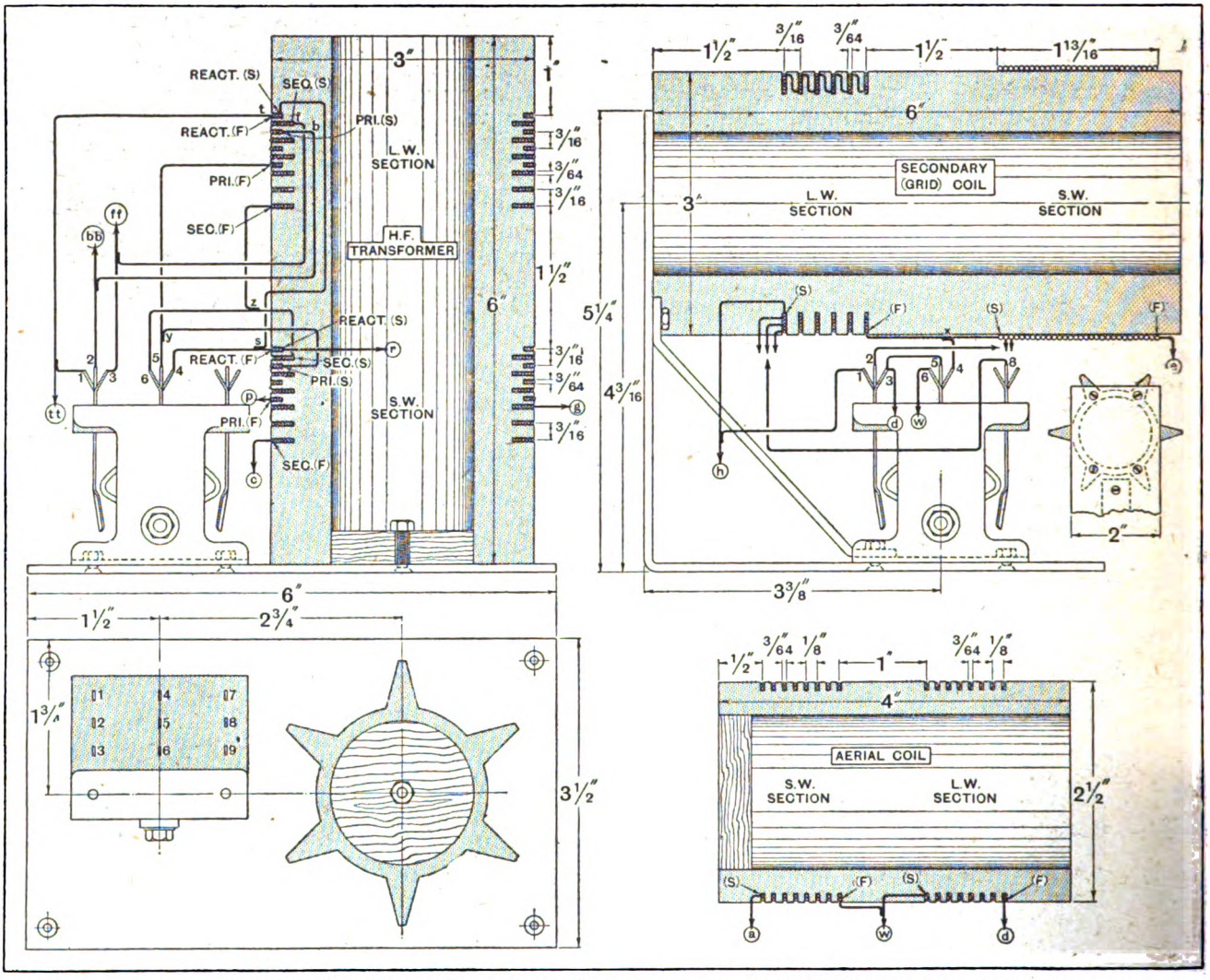

Fig. 2.—CONSTRUCTIONAL DETAILS OF COIL UNITS. The depths of slots are as follows: Aerial coil 3/32in., secondary and H.F. transformer coils, primary and reaction 1/8in., secondary 1/4in. The windings require the following turns and tappings: **AERIAL COIL:** Short wave, 8 sections, 6 turns per section No. 26 D.C.C. Long wave, 8 sections, 20 turns per section No. 32 D.S.C. **SECONDARY (GRID) COIL:** Short wave, single layer 65 turns No. 26 D.C.C. tapped at 2nd and 3rd turns from low potential end: Long wave, 6 sections, 35 turns per section No. 32 D.S.C. tapped at the 3rd, 5th and 6th turns. **H.F. TRANSFORMER:** Short-wave secondary, 6 sections, 10 turns per section No. 26 D.C.C. tapped at 20th turn from high potential end; Long-wave secondary, 6 sections, 35 turns per section No. 32 D.S.C.; Short-wave primary, 3 sections, 11 turns per section No. 38 D.C.C.; Long-wave primary, 3 sections, 35 turns per section No. 40 D.S.C.; Short-wave reaction, single section, 8 turns No. 38 D.C.C.; Long-wave reaction, single section, 20 turns No. 40 D.S.C. The start and finish of each winding is indicated by (S) and (F) respectively and connections to other parts of the circuit are indicated by circled lettering.

similar tapping on the long-wave secondary would considerably complicate the switching so that the grid circuit damping is somewhat higher on long waves. Experience shows, however, that the use of reaction compensates for this shortcoming to a marked degree. In order that the degree of positive bias may be adjusted to suit different types of valves and to permit the use of a 2-, 4- or 6-volt filament circuit, a semi-variable potentiometer has been incorporated, the use of which will

may at first sight seem superfluous, seeing that there is already a by-pass in the form of the reaction condenser R.C., but it is essential to the proper working of the circuit, and conduces to H.F. stability and smooth reaction control.

The remainder of the circuit is perfectly straightforward and calls for little further comment. Anode feed resistances have been introduced wherever necessary, and the receiver can be relied upon to work

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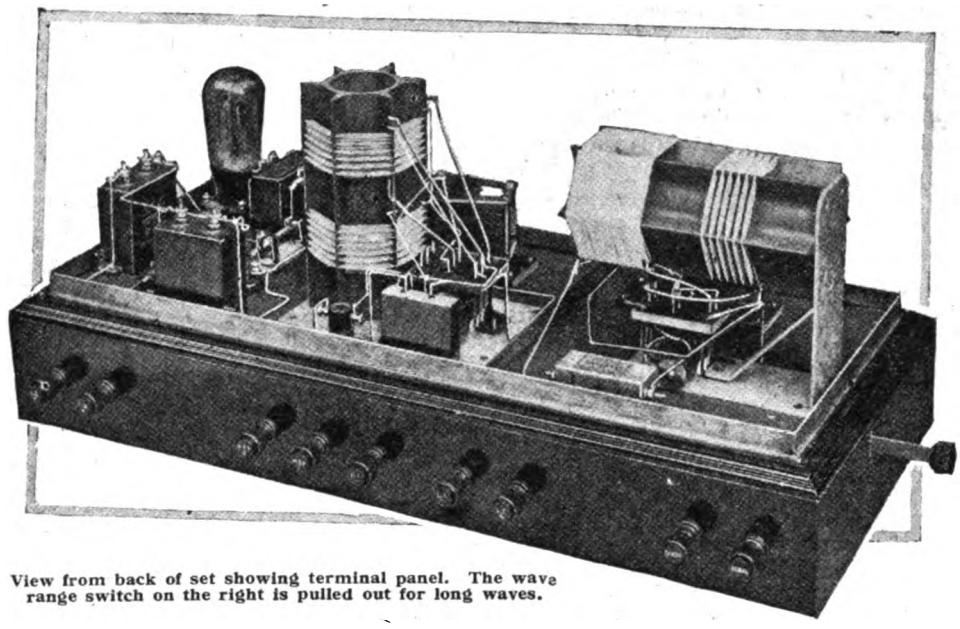
The Wireless World "Kit" Set.—

from any standard battery eliminator without fear of "motor-boating."

Components.

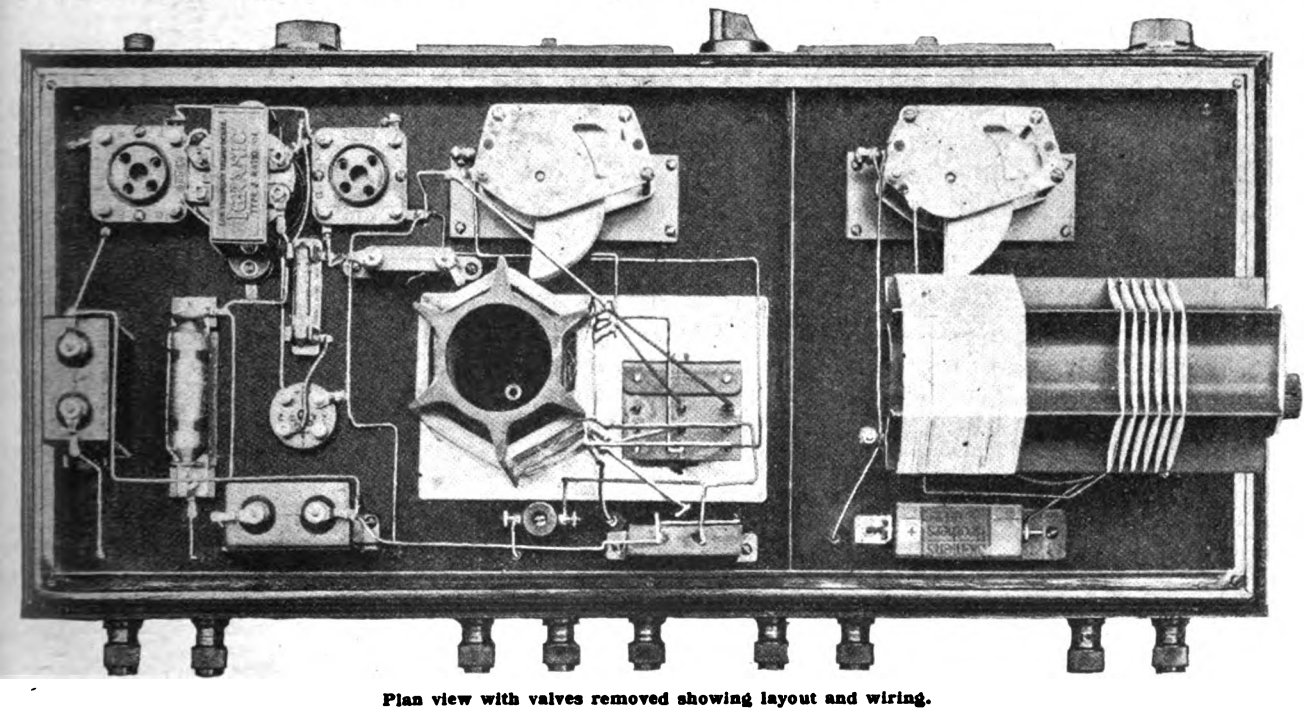
With the exception of the coil units, which have been specially designed for this receiver, wide latitude is permissible in the choice of components. Provided the following qualities are retained, any parts of reputable make can be substituted for those used in the original design, if the constructor so desires.

In the first place the two variable condensers tuning the aerial secondary and H.F. transformer must be mechanically rigid, and there must be no trace of side or end play in the bearings, or this will be magnified at the edge of the large diameter dials. Also, the depth of the fixed vanes or end plates, measured from the centre of the spindle, must not exceed 1½in., or the front edge of the condenser will interfere with the fitting of the cover at the front, and may result in short-circuiting the grid cell. Any good L.F. transformer having a ratio of approximately 3:1 is suitable provided the primary is capable of carrying up to 3 or 4mA. without saturating the core or seriously affecting the characteristics of the transformer. The H.F. choke should be compact and preferably of the binocular or astatic type with a view to keeping the external magnetic field within reasonable bounds. Finally, the paper dielectric by-pass condensers must be reasonably non-inductive, preferably of the type in which the foil is tapped at frequent intervals.



View from back of set showing terminal panel. The wave range switch on the right is pulled out for long waves.

To simplify assembly, the coil units have been designed with integral change-over switches, and it is anticipated that these units will soon be available ready made and wired from those manufacturers specialising in this type of work. For those who may wish to construct their own coils full details are given in Fig. 2. The aerial coil, which is mounted under the base, is



Plan view with valves removed showing layout and wiring.

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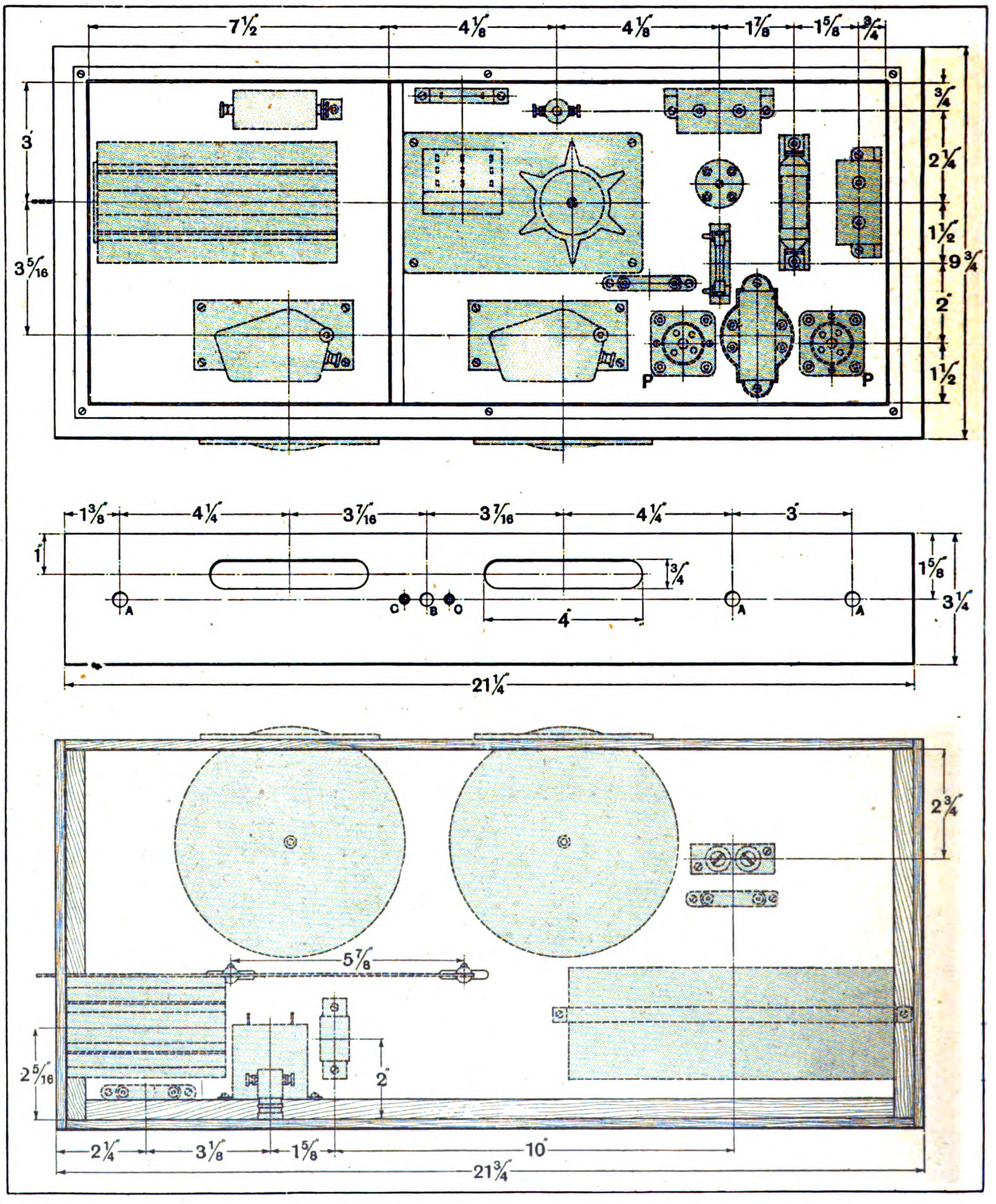

Fig. 3.—Layout of components and drilling details of front panel of base. A, 3/8in. dia.; B, 5/16in. dia.; C, 1/8in. dia., countersunk for No. 4 B.A. screws.

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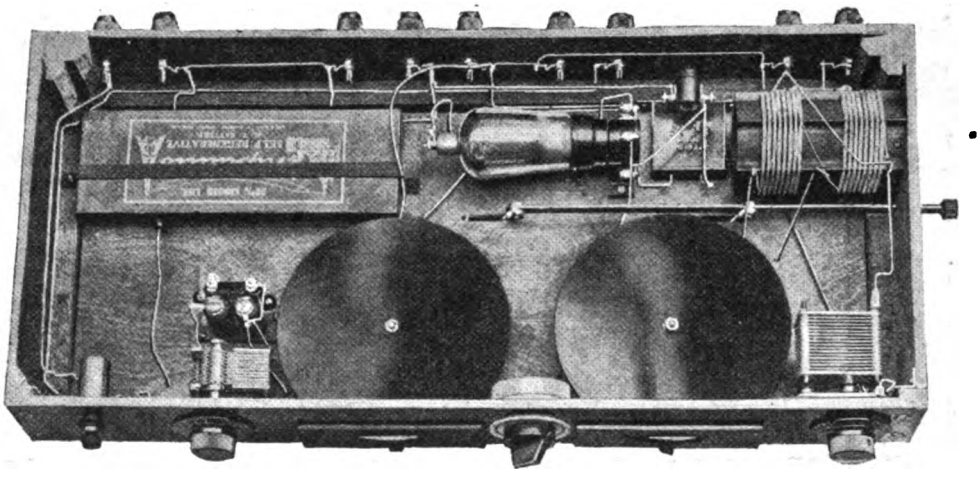
LIST OF PARTS.

2 Variable condensers, 0.0003 mfd., Type No. 3 (Polar).
1 Variable condenser, 0.0003 mfd. (Utility, "Mite.")
1 Variable condenser, 0.0005 mfd. (Utility, "Mite.")
2 Condenser dials, 5¼in. dia. and escutcheon plates.
2 Fixed condensers, 2 mfds. 400 volts D.C. test (T.C.C.).
2 Fixed condensers, 0.1 mfd., 400 volts D.C. test (T.C.C.).
1 Fixed condenser, 0.0001 mfd., mica (T.C.C.).
1 Fixed condenser, 0.0002 mfd., mica (T.C.C.).
1 Fixed condenser, 0.0003 mfd., mica (T.C.C.).
2 Valve holders (Formo).
1 Anode resistance, 20,000 ohms and holder (Ferranti).
1 Grid leak, 2 megohms (Dubilier).
1 Porcelain base for above (Bulgin).
2 Decoupling resistances, 600 ohms (Wearite).
1 Fixed potentiometer, 4,000 ohms (Polar).
1 Rheostat, 50 ohms (Igranic).
1 L.F. transformer, ratio 3 to 1, Type J (Igranic).
1 Special S.G. cell (Siemens).
1 Grid bias battery, 15 volts (Ripaults).
1 On-and-off switch, Type W.188 (Utility).
1 H.F. choke, Binocular Junior (McMichael).
9 Ebonite shrouded terminals (Belling-Lee).
1 Special metal cabinet (Ritherdon & Co., Ltd., North Bridge Mills, Deansgate, Bolton).
1 Special aerial coil unit.
1 Special aerial grid coil unit incorporating switch.
1 Special H.F. transformer unit incorporating switch.
Glazite, screws, etc.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed, and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

wound on a 2½in. dia. shallow-ribbed former, and is fitted with a wood disc at one end for fixing to the side of the wood plinth. The secondary (grid) coils is mounted horizontally, and is wound on a 3in. dia. deep-ribbed ebonite former. The supporting bracket is bent up from thick sheet aluminium, braced at the corner, and the switch secured from below with the countersunk screws to give a flush fitting base. A slot is cut in the aluminium to pass the switch operating knob. The H.F. transformer and switch are mounted on a rectangular aluminium base plate with holes at each corner for baseboard fixing. The wiring is lettered to correspond with the circuit and wiring diagrams, circled letters indicating external wires from the units to other parts of the circuit.



View underneath base showing condenser dials, aerial coil and screen-grid H.F. valve

Assembly.

The special form of combined cabinet and screening box adopted for this design reduces constructional work to a minimum. The process of assembly resolves itself merely into screwing the components to both sides of the baseboard. The first step is to cut ¾in. clearance holes in the base for the two tuning condenser spindles. A small pilot hole should first be drilled from the top and then the wood underneath should be partly cut away with a ¾in. carpenter's bit. The exact position of this hole from the front edge of the wood plinth will be determined by the diameter of the tuning dials used, and may coincide with the dimension given in the layout in Fig. 3. This distance should be checked before drilling the pilot hole. A ring of small holes round the circumference of a ¾in. circle scribed on the top will soon break away the metal, and the edge may then be finished off with a rat-tail or half-round file. Now make the ebonite condenser sub-panels which measure 4in. × 1½in. with a ⅜in. clearance hole and holes for No. 4 wood screws at the corners, and fit the condensers to the box, making sure that the bushes clear the metal at the edge of the ¾in. hole in the base.

The detachable wood panel at the front of the plinth should next receive attention. First, cut the wood away behind the escutcheon plates and fit the latter in such a position that they do not chafe the condenser dials. Then mount the aerial and reaction condensers, the "volume control" rheostat and the on-and-off switch. To complete the constructional work on the base cut the slot for the switch control rod in the left-hand end of the plinth and drill holes for the terminals at the back; as a refinement the latter may be insulated with ebonite bushes if desired.

The remainder of the components may now be screwed above and below the baseboard in the positions indicated in the dimensional layouts. For this purpose,

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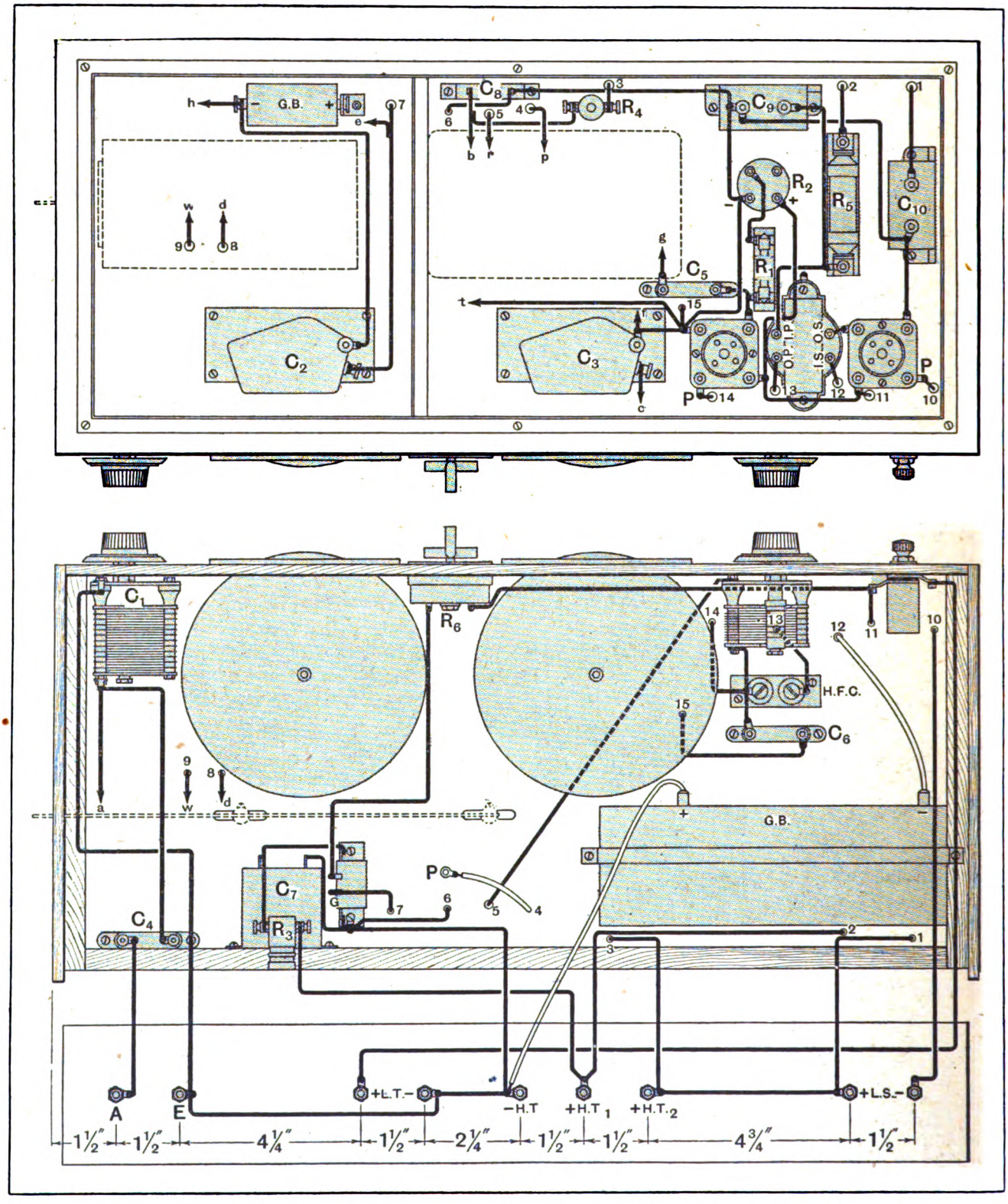

Fig. 4.—Complete wiring plan. Holes through the baseboard are indicated by corresponding numbers. Clearance holes in the metal for wires above earth potential are indicated by large diameter circles; all holes underneath the base in the wood are of small diameter. The lettering corresponds with the coil drawings in Fig. 2 and the circuit in Fig. 1.

B 30

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The Wireless World "Kit" Set.—

wood screws are in most cases satisfactory, but B.A. nuts and bolts may be used with advantage for the L.F. transformer on account of its weight and the valve holder in view of the strains likely to be imposed when inserting or removing the valve. If the fitting of the coil units is left until the last they will be less likely to suffer damage when turning over the base to work underneath.

Wiring.

The process of wiring involves repeated turning upside down of the base, so the first step is to procure two boxes of sufficient height to clear the coils from the bench and to rest the base across these. It is as well to leave the wiring of the coils until last, and to commence in the usual way with wires at low H.F. potential such as H.T. and L.T. leads from the terminals, running these close to the baseboard on either side. Then start working through the set from the loud speaker end to the aerial, using the circuit diagram as a guide in addition to the wiring plan, and marking off wires with a blue pencil on the diagrams as they are fitted. Covered wire such as "Glazite" is convenient, the insulation being removed at the ends by running round the wire with a *sharp* knife or razor blade. As an alternative No. 18 S.W.G. tinned copper wire may be used with "Systoflex" tubing. Holes through the base should be drilled slightly larger than the insulated wire, and in the case of +H.T. leads or wires carrying H.F. the metal only should be opened out with a size larger drill; the smaller pilot hole in the wood will then hold the wire central in the clearance hole in the metal. The L.F. transformer core and case if provided with a terminal or soldering tag should be earthed to the metal base of the set.

To facilitate identification, holes through the baseboard are given corresponding numbers in both the top and bottom wiring plans.

Testing.

Full particulars of suitable valves will be given later. In the meantime, for the purpose of testing, any make of screen grid may be used in the first stage, a 20,000 ohm H.F. valve in the detector and a power or super-power valve in the output stage. To commence with, the tapping points on the secondary (grid) coil may be set at 2 turns for short waves and 5 turns for long waves. This will give average selectivity for purposes of testing and sufficient sensitivity for a large number of foreign stations. About 80 volts for $+H.T._1$ and 120 volts for $+H.T._2$ will be about right, and the grid bias underneath the base should be adjusted in accordance with the requirements of the last valve with 120 volts on the plate. If the connections have been correctly made the set should work first time and give at least three foreign stations on long waves and 10 or 12 after dark on short waves in addition to the B.B.C. local and high-power stations without using reaction.

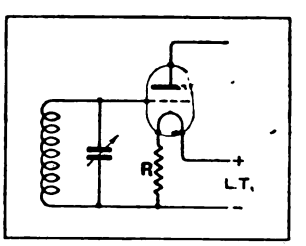
The refinements of tuning and adjustment will be dealt with in next week's issue with full particulars of performance and suggested combinations of valves.

GRID BIAS FOR HIGH-FREQUENCY AMPLIFIERS.

Obtaining Greater Stage Amplification with Less than One Volt Bias.

WHEN using a valve of fairly high amplification factor, whether a screen-grid valve or a triode, as a high-frequency amplifier, it is often well worth one's while to use no more grid bias than is enough to prevent the flow of grid current. By so doing the A.C. resistance of the valve is kept down to a minimum, with a consequent increase in the amplification afforded by the stage.

Since the signal voltage with which a high-frequency amplifier has to deal is only a small fraction of a volt, there is usually no need to use more than a maximum of half a volt grid bias in order to ensure that no grid current flows even at the moments when the signals make the grid most positive. If the grid bias is increased above the necessary minimum, every extra volt of grid bias is equivalent to reducing the anode voltage by μ volts, where μ is the amplification factor of the valve. With a triode for which $\mu = 30$, it is only necessary to use 90 volts H.T. to obtain the results for which 120 volts would be necessary if 1½ volts of grid bias were applied. It is clearly uneconomical to pay for an extra 30 volts of high tension and get nothing for it.



By interposing a resistance R in the negative filament lead of a 6-volt valve, a small bias can be applied to the grid.

With 6-volt valves, one can practically always spare half a volt from the filament battery, so that by putting a small fixed resistance in the negative L.T. lead, as in the figure, the desired grid voltage is obtained. The value of R is computed by dividing 1 by twice the filament current of the valve, so that for a 0.1 amp. filament R would have to be 5 ohms.

With 2-volt valves this simple means of obtaining half a volt usually cannot be adopted, and it is necessary to use a potentiometer connecting the positive terminal of a 1½-volt cell to the slider and setting this at the half-way position. If there is no room for a potentiometer, two equal resistances of about 200 ohms each (8 yards of 38-gauge Eureka) may be substituted, as there is no real need to have the setting adjustable. Alternatively, one may use a 3-volt cell, connecting the positive terminal to L.T. This gives 1 volt of negative bias when the cell is new, but very soon in its life the value will be hovering round the desired half-volt for most of the time during which the cell is in use.

A. L. M. S.

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The Wireless World LYMPIA SHOW COMPETITION

1929 NATIONAL RADIO EXHIBITION 1929

The Purpose of the Ballot.

THIS is now the second year in which *The Wireless World* has held a special competition in connection with the annual Olympia Radio Show, and we anticipate that the results from this year's ballot will be even more interesting than were those of a year ago.

Objects of the Vote.

We had felt for a long time that it would be of interest to all our readers, and to the wireless world generally, to discover what, in the opinion of the majority, were the best products developed by the manufacturers at each successive annual Exhibition. In launching the idea of the competition last year we did so in some trepidation, realising, first, how difficult a matter it was to classify the exhibits fairly, and, secondly, because we had no means of ascertaining the degree to which our readers would respond to the idea and record their votes. But the success of last year's competition more than justifies a repetition of the idea.

In the advertisement pages of this issue an entry form for the competition will be found, and the form will also be repeated in the next two issues of *The Wireless World*. Only one form should be used by each entrant, and the forms need not be forwarded until after Wednesday, October 2nd, but should reach the offices of *The Wireless World* not later than Monday, October 7th. The reason for delaying the forwarding of the entry forms is in order that those readers who are not able to visit the Exhibition personally can have the full benefit of the published reports of the Show, which will appear in this and also in the two further special Show Numbers of *The Wireless World*, to be dated September 25th and October 2nd. These issues will be found very helpful to readers in assisting them in their choice.

All Classes of Apparatus Included.

It should be remembered that only apparatus exhibited at Olympia may be included in the votes, and in choosing apparatus in each class the competitor should be guided in his choice principally by a consideration of the value of the apparatus at the price asked for it in order that low-priced apparatus may stand an equal chance with apparatus for which a high price is asked.

VOTE FOR YOUR CHOICE AT OLYMPIA

We repeat the general instructions for entering the competition. The ballot is organised on the basis that every reader of *The Wireless World* should be entitled to one vote for what he considers to be the outstanding single exhibit at the Show, whether a complete set, a component, or a valve. In order to reduce the possibility of ties each competitor is required, in addition, to vote for one piece of apparatus in each of the following classes into which we have divided the exhibits as a whole. Our classification of the exhibits is as follows:—

(1) Complete receiver of five valves or more, that is to say, receivers exclusive of loud speaker and batteries—unless these should happen to be incorporated as part of the receiver.

(2) Complete receivers or amplifiers of four valves or less, similarly defined.

(3) Batteries of all kinds, including accumulators for both high- and low-tension.

(4) Mains supply units, both D.C. and A.C., and including those which provide filament heating circuits.

(5) Loud speakers of all types.

(6) Valves.

(7) Other apparatus not classified above; also component parts such as transformers, condensers, tuning coils, resistances, etc.

Prizes for Competitors.

Further details of the competition are given on the entry form to be found in the advertisement pages of this and the next two issues.

We believe that our readers will, as last year, welcome the opportunity of taking part in a vote which is of so much general interest, but to add additional attraction to the ballot special prizes are being offered by *The Wireless World*.

A cash first prize of £50 will be awarded by *The Wireless World* to the competitor whose vote agrees with the opinion of the majority in the selection of the outstanding single exhibit and also in the largest number of classes. In addition, second, third, fourth, and fifth prizes to the total value of a further £50, in the form of vouchers for the purchase of apparatus, will be presented. Details of these are to be found on the entry form.

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SHOW FORECAST.

Notes on Some Typical New Products.

WITHIN a week the annual Radio Show at Olympia, organised by the Radio Manufacturers' Association, will be in full swing, and the public will be admitted to inspect for themselves at close range those products of the manufacturers which have been jealously shielded from prying eyes right up to the time of the opening of the doors of Olympia.

Design of Modern Apparatus.

There is always an air of mystery concerning the annual shows of the various industries, for every effort is made to keep confidential, as far as possible, the particulars of new products. Perhaps it is easier in the radio industry than in some others for this information to be withheld until the last minute, because manufacturers find that in the case, at any rate, of component parts, production can be delayed until shortly before the Show. The same argument applied with regard to complete receivers of the past, when these were little more than an assembly of components, but to-day matters have changed very much in regard to receivers, for the methods of manufacture and the general design necessitate that the machinery to be set in motion for the production of complete sets must be ready in good time, and there is no longer the feeling that early release, before the Show, of information regarding receivers might result in special ideas incorporated in them being copied by other manufacturers for their own season's sets, because more time is required in the manufacture of the modern receiver than has been necessary in the past.

In making a statement of this kind it is necessary to enlarge a little and give reasons for it. Receiving conditions have changed, and at the same time the character of some of the apparatus incorporated in the design of modern sets has been radically modified. The public to-day require that receivers should be far more selective than has been the case in the past, because the introduction of the Regional Scheme and the increase in the number of stations abroad which can be listened to with enjoyment have both contributed to make it essential that a degree of selectivity far in excess of the standard of a year or so ago should be a feature of the modern set.

The use of the screen grid valve has made it possible for the modern receiver to provide greater selectivity and amplification, but in attaining these results it is necessary for the designer to pay much closer attention than in the past to design of couplings and to the question of screening. It is these considerations primarily which have made the designing and manufacturing of the modern receiver a more exacting task than it has been in the past, and add to these considerations the fact that the public is now expecting to be supplied with receivers working direct from the mains, everything being incorporated into one outfit, and we have the explanation as to why the tendency in price for complete sets of the most modern type will this year be a little on the upward rather than the downward scale; but we must remember how much more we are getting in the modern receiver as compared with its predecessors.

Mechanical ganging of four circuits simplifies tuning of the Columbia table model cabinet receiver.

In the simpler sets, of which, naturally, there will be a very wide choice at the Show, we shall find that prices have in most cases been substantially reduced, and this season should see the eclipse of the crystal set in favour of valve sets throughout the country. Even the B.B.C., so long the champions of the crystal set user, have at last been forced to admit that under the Regional Scheme the purchase of a valve receiver is to be strongly recommended.

Newcomers in the Industry.

This year we are able to welcome some newcomers in the sphere of broadcast receiver manufacture, notably the Columbia Graphophone Co., Ltd., which enters the wireless industry for the first time, and Graham Amplion, Ltd., who are extending their interests to the production of broadcast receivers, whereas hitherto they have specialised exclusively on loud speakers. The exhibits of Columbia will be found on Stands 94 and 96, and their two principal models of receivers are both five-valve types, one a Table Model 304, and the other a portable receiver. It must be pleasing to a designer to come into the field of set manufacture with, as it were, a clean slate, able to look round and gather ideas and develop entirely new designs unhampered by any past traditions of his firm in the matter of broadcast receiver design; it is, therefore, not surprising to find that these firms which have just entered the field of receiver manufacture should have products of special interest.

The Columbia Table Model 304 is housed in a cabinet reflecting the severe simplicity of modern decoration, and is available in three types for operation from A.C. or D.C. mains or batteries. The first three stages are devoted to H.F. amplification with screen grid

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Show Forecast.—valves and transformer coupling, and the constants of the tuned circuits have been adjusted to give the maximum selectivity, consistent with good quality of reproduction. Mechanical ganging has been introduced for the four tuned circuits, but individual adjustment is possible when receiving distant stations. The tuning drum is calibrated directly in wavelengths, and wavebands covered are 230-550 and 1,000-2,000 metres.

The H.F. stages are followed by an anode bend detector feeding through resistance-capacity coupling to a super-power output valve operating on 200 volts. The comparatively small degree of L.F. amplification means that the H.F. input to the detector must be large, and this valve is, therefore, functioning under most favourable conditions. A volume control is incorporated, giving a wide range of output power.

An interesting feature of the A.C. model is the use of a Westinghouse rectifier for feeding the filament circuits.

The Model 303, Columbia Portable, is also a five-valve receiver, but in this case only two valves are devoted to H.F. amplification, and all valves are of the

Amplion standard mains-operated 5-valve receiver shown on Stands 164 and 187. The last two valves are connected in parallel.

three-electrode type. The first H.F. stage is tuned and is supplemented by reaction, while the second stage is aperiodic. The leaky-grid detector is followed by two transformer-coupled L.F. stages, the output valve being of the power type, feeding into a cone loud speaker of matched impedance.

The portable receiver is adaptable for mains operation, and A.C. and D.C. eliminators for this purpose are available at 10 guineas extra.

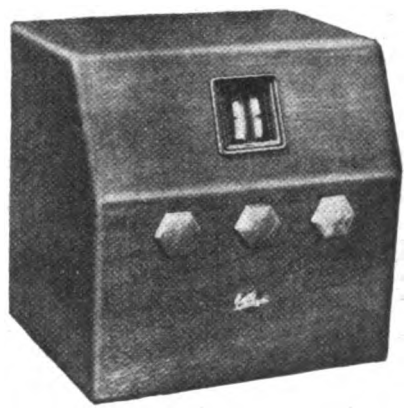
The outstanding receiver in the Amplion productions is their standard mains-operated set for A.C. supply. It is a five-valve receiver of four stages, the last stage consisting of two super-power valves in parallel, with a 10-watt dissipation. A screen grid H.F. stage is employed, followed by detector and a L.F. stage leading to the power output stage. The set is also designed for use with electrical reproduction of gramophone records, plug and jack being provided for connection with the gramophone pick-up. The receiver strikes a distinctive note because of its compact appearance and extreme neatness. It has the hallmark of careful design and execution which will make a strong appeal to the public.

Another receiver of outstanding merit, which is also distinctive because of the simplicity of its appearance, is the Marconiphone Model 56, which is also designed to operate from the mains, but this time by the employment of a separate unit. The receiver incorporates three screen grid valves, detector, and a pentode for the output stage. The

Conveniently placed drum controls and all metal cabinet are the outstanding features of the Marconiphone Model 47 mains-operated receiver.

appearance is very pleasing, the set being housed in a mahogany cabinet with tuning by means of two edgewise dials in the centre of the cabinet, tuning being by ganging. Provision for using the receiver for electrical gramophone reproduction is also a feature, whilst a special point of interest is the new type of volume control, independent of tuning.

Another interesting receiver is the Marconiphone Model 47, which is accommodated in a metal cabinet and is designed solely for use with A.C. mains, the entire mains unit being incorporated within the receiver. This receiver consists of one H.F. screen grid valve, detector, and two L.F. stages, and it is a



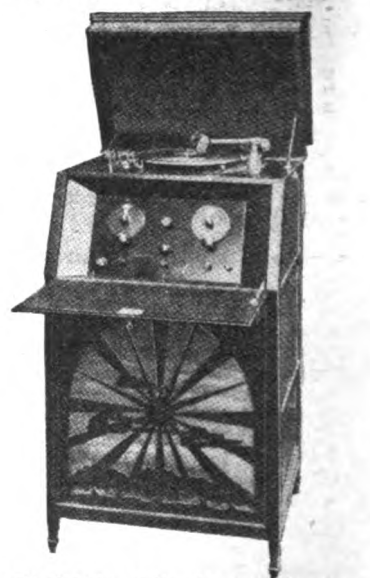
Marconiphone cabinet set, Model 39, incorporates a screen-grid H.F. stage and a pentode output valve.

mass-production job, which has made it possible to produce it at a highly competitive price.

Model 39 is another new product of the Marconiphone Co., consisting of screen grid stage, detector, and pentode. Two edge control dials are set together in the sloping panel of the mahogany cabinet; the set can be operated from a mains unit or from batteries. This is a very well finished receiver, which is bound to be popular, and will be found on Stands 79 to 84.

Just as a year ago the most popular sets were of the four-valve class, now it seems that with the increasing efficiency of valves and general design the outstandingly popular receivers this year are likely to be three-stage sets operating from the mains, with screen grid H.F. valve, and in many cases a pentode output stage. The Igranic Electric Co. will show a new receiver to this specification on their Stands Nos. 161 and 162. The receiver embodies a number of novel features which will be examined with interest. The set is available in various forms of handsome cabinets, and one type incorporates an electric gramophone and a new self-contained frame aerial. Those interested in short-wave receivers will also find two interesting examples of modern short-wave receiver practice exhibited on these stands.

Burndepts have always maintained a high reputation for the quality of their



An all-electric radio gramophone set. Three valves are employed, one of which is a screen grid H.F. amplifier. An Igranic product.

products, and this year what will probably be regarded as their outstanding exhibit will be the "Ethogram" All Mains A.C. Radio-Gramophone. The radio amplifier equipment of this instrument is similar to the Burndept A.C. Screened Seven receiver, and consists of two screen grid H.F. stages, anode bend detector, followed by a resistance coupled stage feeding two super-power valves arranged in push-pull as the output stage. The receiver is designed to provide all current and voltages, including grid-bias, from A.C. mains. Tuning is by means of a single drum control, and two additional controls serve; one for volume regulation, whilst the other rotates the frame aerial. The Burndept special "Needle Armature" gramophone pick-up is used, and the equipment is designed so that a reed-driven cone or a moving-coil

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Show Forecast.—

loud speaker can be incorporated according to the choice of the purchaser. An early inspection indicates that other receivers of Burndept production will also be of a very high standard.

Naturally, one must wait until the opening of the Show before it is possible to attempt to cover, in a review of the

Burndept "Ethogram" A.C. mains-operated radio gramophone. To be found on Stands 144 to 147.

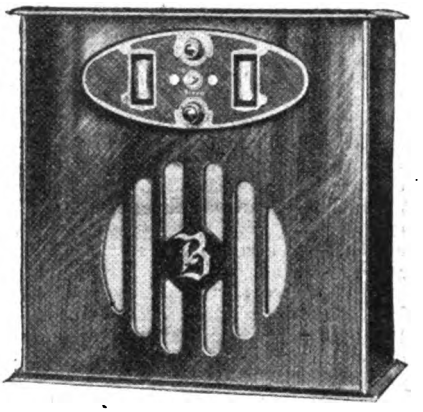
Exhibition, even a small proportion of the apparatus of special merit which Olympia will present. It is only possible at this stage to forecast the general tendency of design by illustration of certain particular sets as good examples of their class.

Kolster-Brandes products, exhibited on Stands 176 to 179, are distinctive in appearance, and will undoubtedly attract attention, particularly on the score of their low price. The All-Mains three-valve receiver is entirely self-

Kolster-Brandes all mains receiver, Type 161. Three valves are used, and it is entirely self-contained.

contained, so that it can be connected direct to the electric lighting point.

Amongst battery-operated receivers the

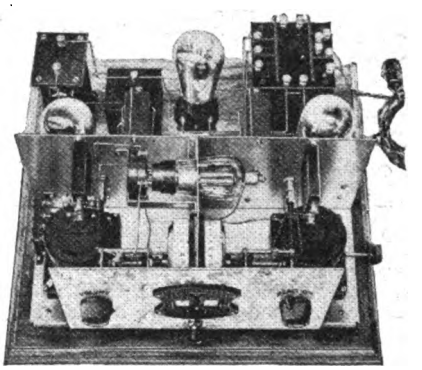


S G. Brown's kit constructors' 3-valve receiver. A screen-grid H.F. valve is used.

K.B.102 is a screen grid, detector, and pentode set, selling at £9 15s.

Another pleasing example of a three-valve receiver with screen grid H.F. stage will be shown by Messrs. S. G. Brown on Stands 213 to 215. The set is designed particularly with a view to selectivity, in order to make it suitable for the Regional Scheme. The receiver is one intended for home construction, and full details for building are supplied with the parts. Another kit of parts consisting of a three-valve screen grid and pentode output receiver designed to operate from the mains will certainly attract attention.

On Stand No. 63 Messrs. Garnett, Whiteley and Co. are showing their products under the well-known name of

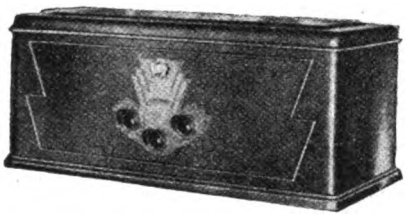


"Lotus" A.C. mains receiver, also supplied in kit form for the home constructor.

"Lotus," and amongst sets it will be of interest to examine their three-valve standard screen grid all-mains receiver with a pentode output stage. A.C. valves are used, and special attention has been paid to selectivity. This receiver is also available in the form of a kit for home construction, everything being in readiness for easy assembly, and full consideration has been given to the question of screening and convenient tuning control.

Kits of parts for home construction certainly appear to have appealed to the manufacturer this year. Cossor's 1930 "Melody Maker" is a constructor's set of outstanding interest which, in anticipation of big sales, is being produced on mass-production methods. The cabinet is pressed steel, handsomely finished to imitate the appearance of leather. The set is available both for mains and battery operation, and those who purchase the battery kit can at any time add the battery eliminator, as sufficient space is provided.

An interesting point in connection with the design is that, realising the difficulties of the home construction of an efficient tuning unit from component parts, the designers have incorporated the



The Cossor 1930 Melody Maker.

tuning condensers, coils, and change-over switch from long to short wave, and the necessary associated screening all within one sealed box, which is supplied as a distinct unit to be treated as one component with external terminals for connection to the other components.

Portable sets will no doubt be more in evidence at this Exhibition than ever before, for certainly the portable set has achieved great popularity with the public during the past few months. But we must never lose sight of the fact that the portable set is still something in the nature of a compromise, manufacturers being very definitely handicapped in designing such receivers, because they have to take

The Lissen portable to be found on Stands 184 to 186. A 5-valve receiver with one dial tuning.

into consideration the question of weight and portability. But, as we know from past reviews in *The Wireless World*, portable sets of marked efficiency are

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Show Forecast.—
being evolved by the British manufacturer.

Amongst new portables may be mentioned the "Lissenola," which is a five-valve receiver with one-dial tuning and providing long- and short-wave reception.

Four valves are used in this Selector transportable receiver. The tuned H.F. stage has a screen-grid valve.

An outstanding example of semi-portable, or so-called transportable, receivers is the "Selector Cabinet Portable," which will be seen on Stands Nos. 102 and 104. This is a mahogany cabinet four-valve receiver, for which a remarkable performance is claimed. A screen grid H.F. valve is employed, and calibration charts for each receiver are supplied.

Electrical gramophone reproducers have very definitely taken their place amongst the legitimate products of the radio manufacturer, and we are promised a number of notable examples at Olympia this year. The Symphony Gramophone Radio Co., on Stand 132, will be showing fine examples of radio gramophones, where very special attention has been paid to handsome appearance of design and finish of workmanship, but their star model is undoubtedly

A handsome cabinet houses this "Symphony" de luxe radio gramophone. It includes an electrically-operated gramophone and moving coil loud speaker.

the All-Electric Radio Gramophone *de luxe*, which is a most attractive piece of furniture as well as a radio gramophone. An electric motor drives the turntable; the radio receiver and gramophone amplifier is a unit in itself, mounted within the cabinet on an all-metal chassis and totally enclosed, with the exception of the valves. Indirectly heated valves are employed, and the output is sufficient to provide dance music for a small hall, if necessary. A self-contained frame aerial feeds a screen grid high-frequency stage for radio reception, and the loud speaker is of the moving coil type with a special form of suspension.

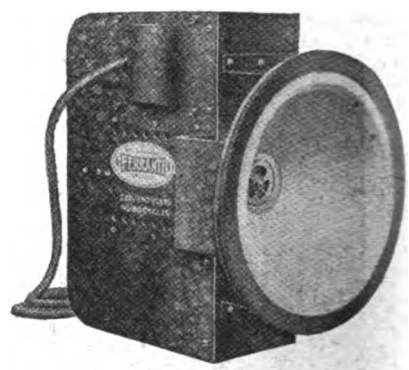
The quality of the products of Gambrell Radio, Ltd., has always been of a high order, and amongst the new apparatus which they will be showing this year special interest attaches to the Gambrell radio gramophone, which is designed in two models, operating from direct or alternating current. The turntable is driven by an electric motor and the receiver is a four-valve instrument with screen grid, H.F., and pentode output. Tremendous volume, with excellent

Gambrell's version of an all-electric radio gramophone. Four valves are used, including a screen grid and a pentode. Shown on Stand 62.

quality, is provided, and on the receiver side good selectivity. Both these models can also be fitted with a new device known as the "Novotone," which will be shown at the Exhibition and demonstrated for the first time. The "Novotone" is a special tone compensator invented by Dr. N. W McLachlan, the special object of which is to compensate for the fact that the gramophone record does not take care of the low or the high frequencies in proper proportion. The effect of the "Novotone" unit is to correct the overall characteristic of the amplifier so as to bring up both high notes and the bass to their proper proportion and so effect a cure for the inherent shortcomings of the gramophone record. The instrument is a noteworthy contribution to the technique of gramophone reproduction by electrical means.

LOUD SPEAKERS.

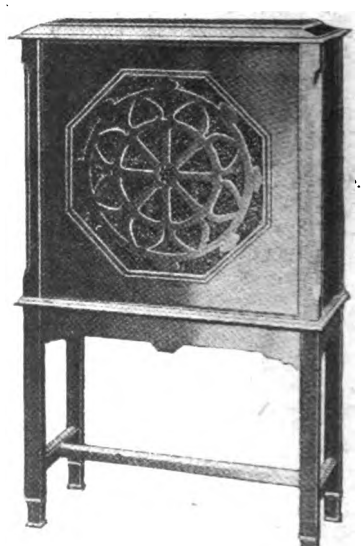
The construction of loud speakers is a new departure for the house of Ferranti, Ltd., but since this firm have had such a wide experience in the design of mains equipment it is perhaps understandable that their energies should be directed to-



Ferranti A.C. mains-driven moving coil loud speaker. An input transformer is incorporated.

wards the production of a mains-operated moving coil instrument. Some examples of these will be shown on Stands Nos. 74 and 76. There will be two types, the S.A.1 and the S.D.1; the former is for use on A.C. supply mains of from 200 to 250 volts, 40 to 100 cycles, and incorporates a valve rectifier. The other model is somewhat similar in general construction, but without the rectifying equipment, and is intended for use where the electric supply is of the direct-current nature. At present chassis models only are available, but cabinet assemblies are under consideration.

Celestion loud speakers need no introduction in general, but on their stands, Nos. 180 and 183, will be shown some entirely new models this year. This



Celestrola moving coil loud speaker. A new product of Celestion, Ltd.

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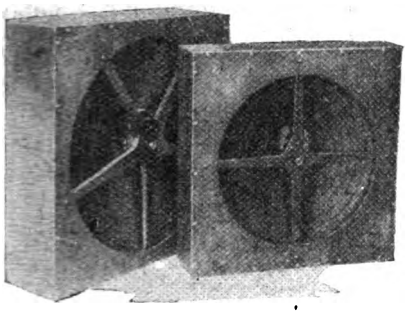
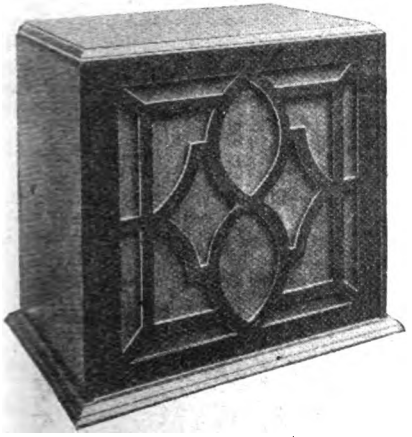
firm, which has in the past specialised in the reed-operated mechanism, has now developed a moving coil type loud speaker, known as the Celestrola. This is supplied for mains excitation of the field coil, or for use with a 6-volt accumulator to meet the requirements of those not having access to the electric supply mains. Mains models are made to suit 110- or 220-volt A.C. supplies, and these incorporate a transformer, rectifier, and input transformer. The D.C. model is made for 110- and 220-volt



Celestion shell case models for fitting into cabinet receivers.

mains, and includes an input transformer. These are built into handsome pedestal cabinets, and can be supplied in oak or mahogany.

The home constructor's requirements are being catered for by the introduction of a range of shell-case reed-type loud speakers fitted with Celestion reinforced diaphragms. These are housed in plain



New model Marconiphone moving coil loud speaker with pressed diaphragm.

wooden cases open at the front and supplied with 10in., 11in., 12in., and 14in. diaphragms. A special feature of this year's exhibits is an all-round reduction in prices of their standard models, made possible by the acquisition of a more efficiently equipped factory and a thorough reorganisation of production.

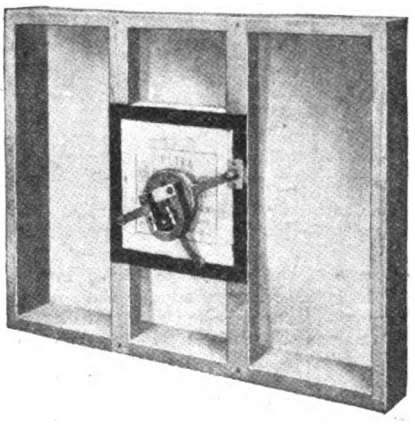
The Marconiphone Co., Ltd., are showing a new model moving-coil loud speaker and two additional reed-operated cone-type instruments on Stands 79 to 84 inclusive. In the moving coil model the diaphragm is pressed from a fibrous buckram material, and it has been found possible to dispense with the centring

Unorthodox but pleasing design is the feature of the Symphony Gramophone and Radio Co.'s "Oval" loud speaker.

spider fitted to the earlier model. At the forward end of the cone the suspension used follows approved practice. The field coil is wound for 200-250 volts, and requires about 60mA. of current. A unit, fitted with a Marconi U.9 rectifier, is available for use on A.C. supply mains. The instrument is housed in an attractively designed and well-finished mahogany cabinet.

A rather novel and unusual design is adopted by the Symphony Gramophone and Radio Co., Ltd., in their "Oval" loud speaker. The mechanism follows well-tried practice, and consists of a reed-type movement driving a cone diaphragm. The cabinet, however, is oval in shape, the front being acoustically open, but covered by a grill made from woven cane. This is to be exhibited on Stands Nos. 129 and 132.

The use of linen diaphragms for reed-operated-type loud speakers is not new in the literal sense, since these have been in being, but mainly in experimental form, for some time past. The commercially made article, however, is sufficiently recent to justify inclusion in the new season's products. Some good ex-

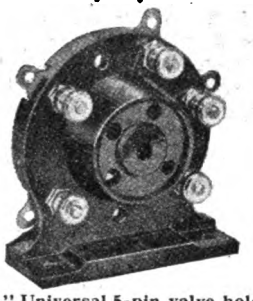


"Ultra Air Chrome" linen diaphragm loud speaker for incorporating in cabinet receivers. A balanced-armature movement is used.

amples of these instruments will be shown on Stand No. 106, the Ultra Electric, Ltd., under the name of Air Chrome loud speakers. Skeleton models, as well as cabinet types, will be exhibited. These instruments are fitted with double linen diaphragms and a balanced armature movement. From the performance curve of this particular design it appears that the response is exceptionally good, and particularly constant between 70 cycles per second and 7,000 cycles, and if this can be maintained in all production models this loud speaker should enjoy well-merited popularity.

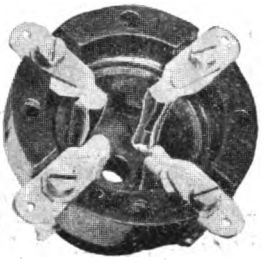
COMPONENTS.

It is difficult at this stage to give anything more than a brief description of the new components that will be seen this year, as the majority of manufacturers



"W.B." Universal 5-pin valve holder. A Whiteley Boneham product to be found on Stand 66.

are mainly concerned with putting the final touches to their principal exhibits. From what can be gleaned, however, it would appear that most of the really new accessories have been developed to meet some special requirement. For example, the advent of the new five-pin A.C. valves has necessitated a special valve-holder, and examples of these will be



"Clix" special low-loss valve holder.

found on the stand of Messrs. Whiteley, Boneham & Co., Ltd. One model, a rigid type, especially designed for 5-pin screen-grid valves, can be mounted to support the valve either vertical to or horizontal to the baseboard. A good electrical contact is assured by the use of expanding leg sockets made from stout nickel silver. An extension of these provides soldering tags, but terminals are fitted also.

An anti-microphonic holder possessing exceptional low loss qualities is to be included in the exhibits of Lectro Linx, Ltd., Stand No. 261. The moulded shell

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is hollow, and the spring sockets are anchored at each end but do not otherwise touch the moulded material. Since the sockets are surrounded by air the capacity effects will be exceptionally low, and, moreover, the leakage paths will be reduced to a minimum.

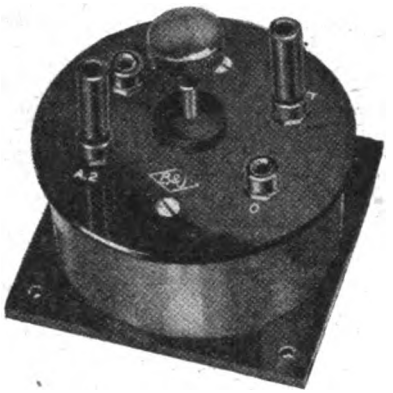
An addition to the "Belling-Lee" wide range of terminals is an S.G. valve anode connector to completely insulate the top terminal and its connecting wire from adjacent metal work. Its special function is to provide a measure of safety against accidental damage to the H.T. supply, and possibly more delicate components, should the anode connection come loose and trail dangerously among the wires in the set. This useful accessory will be found on Stands Nos. 263 and 264. Here will be found, also, other safety devices, such as a baseboard fuse holder, which consists of a bakelite moulding carrying a cartridge type fuse and two connecting terminals. Those who cannot conveniently incorporate a

Burne-Jones "Magnafilter" for rejecting undesirable transmissions.

fuse inside the set will find that their particular requirements have been catered for in the form of fuse adaptors which can be fitted to any Belling-Lee wander plug, spade, or pin terminal.

Among the new "Magnum" products —Messrs. Burne-Jones and Co., Ltd., Stand No. 125—will be seen a very interesting volume control. This is known as the "Dissolver," and is in effect a dual volume control. When used in conjunction with an amplifier supplied from two different sources of electrical energy, such as a gramophone pick-up and the detecting portion of a broadcast receiver, for instance, the output from one source can be slowly reduced to zero and the signals from the alternative source gradually brought up to full volume. It could be used, of course, with two gramophone turntables and a similar effect produced.

Many who now enjoy comparative freedom from interference may have a different story to tell when Brookmans Park, and other regional stations, commence operations, but in the majority of cases a rejector will overcome their difficulties. An excellent example of this accessory is the "Magnafilter," to be shown on the "Magnum" stand. This piece of apparatus should be connected between the aerial and aerial terminal of the set;



"B. & J." wavetrap; Litz wire is used for the coil.

no alterations, whatsoever, being necessary to the receiver. By its aid a powerful local transmission can be rejected and the alternative programme received free from interference. Wave filters, or rejectors, do not enhance the sensitivity of a set; they merely improve the selectivity under certain conditions.

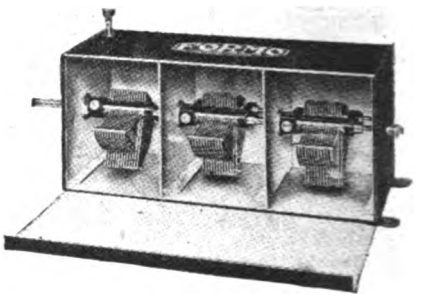
The B. and J. Wireless Co. will exhibit on Stand No. 233 a wavetrap, which we venture to think will be found highly efficient, since the coil is wound with Litz wire. The aerial should be disconnected from the set and reconnected, by means of a plug, to socket "A_1" or "A_2" on the wavetrap. The "A" socket is then joined to the aerial terminal on the set in the usual manner.

An exhibit that should hold some interest for the portable set user will be

Benjamin Electric Co.'s turntable fitted with short folding legs for outdoor use.

found among the components on Stand 31—Benjamin Electric, Ltd. This is a turntable fitted with folding legs, and enables the set to be raised above ground level when used in the open. Better performance should result, since the frame will have a lower capacity to earth. Rubber buffers are fitted, so that when the legs are folded back the set can be used indoors in the normal manner.

A visit to the Formo Co.'s stand, No. 72, will be well repaid, as a number of new components are to be shown, in addition to numerous modifications to many of last season's products. A vernier dial with the aperture and scale inclined at an angle of 30° from the perpendicular has been evolved to enable the scale to be read conveniently when operating the set. Those who are particularly keen on experimenting with ganged circuits will be interested in the screened gang condenser units. Dual and triple units are to be shown, and each condenser, which is of the "log" type, is totally enclosed in a separate compartment. Provision is made for adjusting the relative position of the first condenser to correct slight differences in the self capacities of aerial circuit and H.F. circuits, thereby render-

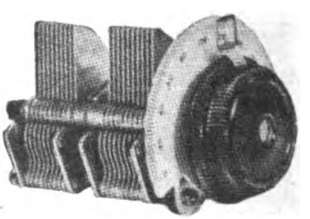


Three-gang screened condenser unit—a Formo product.

ing the ganging of three circuits possible. This correction can be made without opening the screening box.

Messrs. Wilkins and Wright, Ltd., will be showing on Stand No. 115 some examples of ganged condensers. In particular, the "Mite Double Gang" assembly with vernier dial is well worth close examination. Where space is strictly limited these miniature condensers offer a happy solution, since they are compact and take up very little space. There will be displayed, in addition, some specimens of the new "Mite" drum dial condensers, the special feature of which is the large control knob with the aperture for the scale in its centre. A differential reaction condenser, with a capacity of 0.0001 mfd., will be on view also.

An exceptional display of variable con-



"Utility" dual "Mite" condenser with vernier dial.

densers to meet practically every requirement of the experimenter is provided by Messrs. Wingrove and Rogers, Ltd., on their stands Nos, 128 and 133. The "Polar" two-speed drum control incorporates two 3in. knurled edge drums with

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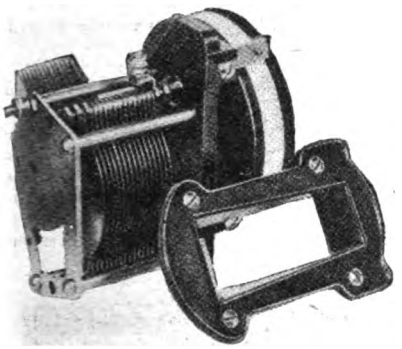
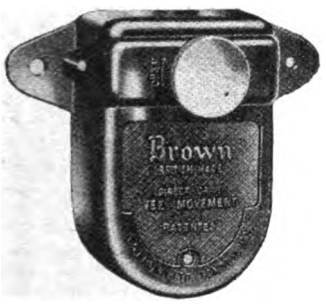
a neat ivorine scale attached to the quick motion drive. It is finished with a handsome escutcheon plate moulded in bakelite, and both right- and left-hand drives



"Polar" drum control condenser with two-speed dial. Right- and left-hand models are available.

are available. Double and triple assemblies will be shown also.

Prominent among the exhibits of Messrs. S. G. Brown, Ltd., on Stands Nos. 213, 214 and 215, will be displayed their "Vee" cone loud speaker units and chassis. Although not entirely new, it is sufficiently recent to attract considerable attention and justify its inclusion in the list of the coming season's new products. One of its principal features is the large electrical input that can be handled before the units show signs of distress. A more recent addition to



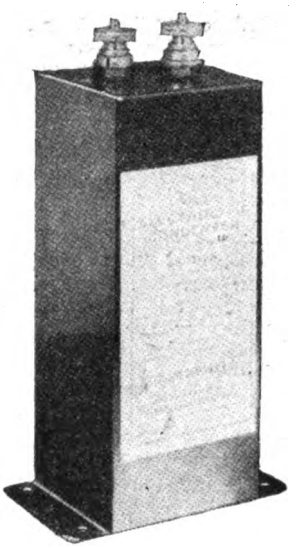
The "Vee" loud speaker unit: a product of S. G. Brown, Ltd.

this firm's small components is a "B" type L.F. transformer, which is similar in some respects to the now well-known type "A," but has a lower primary inductance. The ratio is the same, viz., 3.5 to 1.

An opportunity should be found to visit Stand No. 248, where the Telegraph Condenser Co., Ltd., will be exhibiting many diverse types of fixed condensers. We understand that special attention has been given to the production of large capacity H.F. by-pass condensers of the non-inductive type, and having a low A.C. resistance. This is particularly important in modern sets, since an appreciable resistance in the by-pass condenser will off-set many of the advantages conferred by adopting anti-motor-boating measures.

Some new super-capacity electrolytic condensers will be on view this year. One model, having a capacity of 500 mfds., is designed to withstand a maximum working voltage of 40 D.C., while the 2,000 mfd. type have been entirely redesigned. The leakage current of this model is of the order of 10 milliamps only, and the maximum difference of potential across their terminals must not exceed 12 volts D.C.

An interesting display of components is promised by the Igranic Co. on their Stands Nos. 161 and 162. Among the new components will be a dual-wave coil unit enclosed in a neat bakelite case with soldering tags protruding from the side of the base. The coils cover both medium and long broadcast wavebands



T.C.C. new 500 mfds. electrolytic condenser.

when tuned by a suitable condenser; change from one band to the other being effected by means of a switch. This, however, is not included in the assembly.

An accessory of more than usual interest is the new Burndept "Needle Armature" gramophone pick-up and tone arm, which will be found on Stands 144 to 147. This operates on an entirely new principle. It has been designed having in mind one set of conditions only, showing that those responsible for its being have carefully investigated this matter. The governing factors are: one needle only must be used and the special tone arm is essential if the extraordinarily good characteristics exhibited are to be attained. The natural period of this plays an important part in the output from the pick-up. The general level is of the order of 0.02 volt only, so that rather more than the usual amplification will be required. However, this will be repaid in ample measure, since the variation in the output between 125 cycles per second and 6,000 cycles will be within two decibels either side of the average level. Below 125 cycles the output increases, but this is desirable as a compensation for the restriction in amplitude of the recordings on the lower notes. Above 6,000 cycles the characteristic shows a sharp fall. Nevertheless, there is an appreciable output at 8,000 cycles.

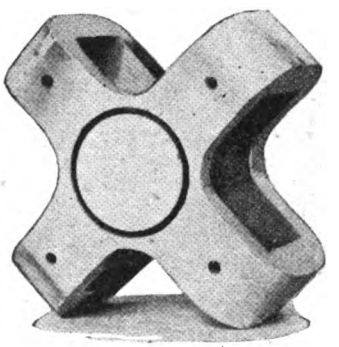
For the home constructor and experimenter with moving-coil and other type

Igranic dual range coil enclosed in a neat bakelite case.

loud speakers, some interest will be found in the exhibits of Messrs. Swift, Levick and Sons, Ltd., on Stand 240. This firm specialise in all kinds of permanent magnet castings, and among their principal exhibits will be a new cross type magnet for moving-coil type speakers. The most interesting feature of the design is that a solid casting is used, with the result that magnetic leakage is reduced to the absolute minimum since there are no joints in the magnetic circuit. It is claimed that a flux density at the gap of between 4,000 and 7,000 lines per square centimetre can be attained, according to the dimensions and weight of the magnet. The gap is accurately mach ned and tapped holes are provided for attachment of the cone chassis.

ACCUMULATORS AND BATTERY ELIMINATORS.

Although there will be many attractive displays of H.T. and L.T. accumulator batteries to be seen this year, we cannot promise any radical departure from recognised standard practice. This is, perhaps, quite understandable, since accumulator manufacturers had years of



Swift-Levick permanent magnet for home construction of moving-coil speakers.

experience before wireless became an everyday source of entertainment. The Chloride Storage Battery Co., Ltd. (Stands 172 to 175) have, however, intro-

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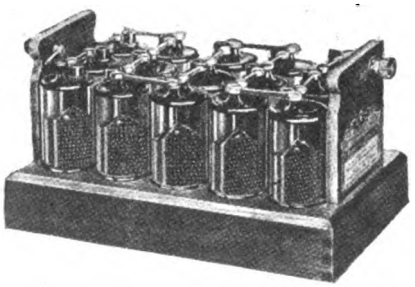
duced a new feature which will be readily appreciated by all users of L.T. cells. Exide low-tension batteries are now fitted with non-interchangeable red and blue terminals. The positive is made octagonal in shape, while the negative remains plain, as hitherto. Thus,

Octagonal positive, and plain negative, terminals are now fitted to all Exide L.T. cells.

these are readily distinguishable in the dark.

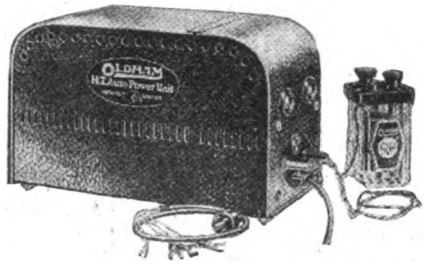
The Hart Accumulator Co., Ltd., have augmented their range of H.T. batteries and introduced some 20- and 30-volt H.T. units assembled in wooden crates which can be stacked one above the other. This has been done to meet the requirements of users to whom floor, or table, space is of importance. Tubular glass containers are employed, and both the positive and negative plates have been covered with sheets of perforated ebonite to prevent dislodging of the active material from the grids. In addition, a wide range of L.T. accumulators for stationary and portable work are to be shown on their Stand No. 289.



These new Hart H.T. units can be stacked one above the other for conservation of table space.

An opportunity should be made to visit Stands Nos. 68 and 70, Messrs. Oldham & Sons, Ltd., as in addition to a fine show of H T. and L.T. batteries this firm have developed a new "H.T. auto-power unit." This consists of a stout metal case with space for an Oldham 120-volt H.T. accumulator in two tiers, and a trickle charger. A four-way cable terminating in a four-pin plug connects the unit to the set, and on withdrawing the plug the cells are automatically put on charge without disturbing the connections on the set. A further improvement in this model takes the form of an additional trickle charger, inside the case, for recharging the L.T. battery also. Westinghouse metal rectifiers are incorporated in these models. Small lamps are fitted to indicate when the cells are on charge. The rear part of the container is removable to allow examination of the cells and "topping-up" when required.

Among the accessories on Stands Nos. 8 to 11—Messrs. E. K. Cole, Ltd.—will be found a range of rectifier units to convert a D.C. battery eliminator into an A.C. mains unit. Since many D.C. supplies are shortly being changed to A.C., this additional piece of apparatus should be found extremely useful. Furthermore, these units can be used as trickle chargers for H.T. batteries. A full range of H.T., L.T., and complete battery eliminators will be shown also.

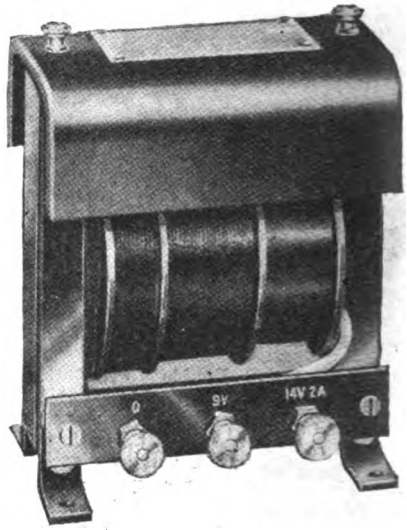


"Oldham" H.T. auto-power unit with L.T. trickle charger included.

Messrs. Partridge & Mee, Ltd., have made many additions to their range of battery eliminators, but the most interesting exhibit in the accessory section will be a selection of skeleton type eliminators for incorporation in home-constructed sets. Valve rectifiers are employed. In addition there will be on Stand 98 three new mains transformers for use with Westinghouse metal rectifiers. Type 2B is a low voltage model for use in L.T. chargers, and H.T.3 and H T.4 are the high voltage types designed especially for the Westinghouse H.T.3 and H.T.4 metal rectifiers.

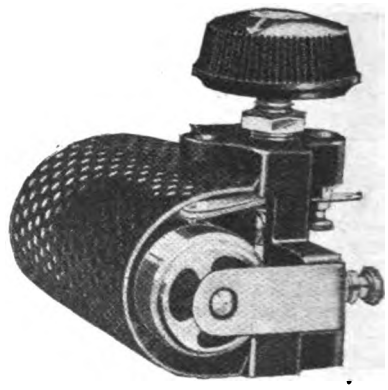
A new P.M. filament transformer giving 4 volts at 5 amps. will be included in the Mullard exhibits this year on Stands 58, 117, and 134 to 137. It has been designed to supply current to the heaters of the new A.C. valves developed by this firm, and will be available in various types suitable for A.C. mains of from 100 to 250 volts.

The Varley Co.'s exhibit on Stands 154 and 159 includes many new features. In particular the Multi-volt power transformer, for use with a valve rectifier, and rated at 50 watts, should hold the interest of the experimentally minded. This single component provides 250+250 volts at 60 mA. for the H.T. supply; 2.5+2.5 volts at 2 amps. for a 5-volt rectifier; 3+3 volts at 2 amps. for the filament of a power output valve; 0.8 volts at 5 amps. and 4 volts at 2 amps. for directly and indirectly heated



Varley multi-volt transformer; a universal voltage provider; it has five separate secondary coils and is rated at 50 watts.

valves. It is wound for A.C. mains of between 40 and 100 cycles and for 100-120 volts or 200-250 volts. Before leaving this stand the range of power potentiometers should be examined. There will be seven types in all, varying from 400 ohms to 50,000 ohms maximum. They are wire-wound and rated to dissipate 25 watts. The resistance bobbin is protected by a shield and is removable from its holder. Thus, values can be changed, if desired, without removing the component from the panel. An added refinement is provision for rotating the resistance bobbin and thereby exposing a new track for the slider.



Varley power potentiometer with removable resistance bobbin.

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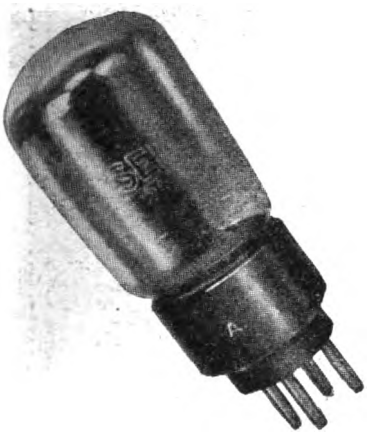
VALVES.

With the latest addition of valves to their already extensive range of radio accessories, it is interesting to record that Lissen, Ltd., now manufacture everything required for wireless reception. The full range consists of eight valves with 2-volt filaments and includes a screen-grid valve and two pentodes, also five triodes. These are the usual H.F., R.C.C. and L.F. types, and two power output valves, the P.220 and P.X.240.

Several new valves will figure among the



Lissen P.220 small type power amplifying valve.

well-known Mullard P.M. series this year. Of special interest are the new 5-pin A.C. valves fitted with indirectly heated cathodes and consuming 1 amp. at 4 volts. These comprise a screen-grid valve, type S.4V., which possesses the extraordinary amplification factor of 1,000; the A.C. resistance, however, is on the high side, viz., 1.33 megohms. Types 354V, 164V, and 154V all possess mutual conductances of two or over. The 104V is the super-power output valve, and gives an amplification of 10 with an A.C. resistance of 2,850 ohms, the mutual conductance being 3.5 mA. per volt.

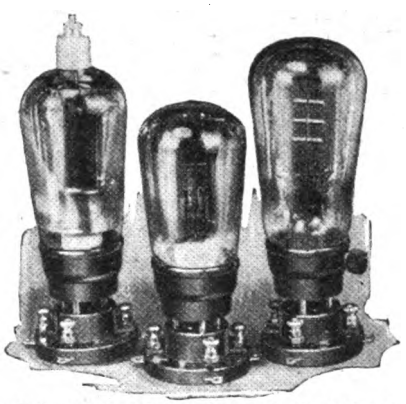
Marconi valves have been overhauled and a few new types introduced. A new pentode P.T.240 with an A.C. resistance of 55,000 ohms and an amplification factor of 90 figures in the 2-volt class, while the 4-volt range has been augmented by pentode P.T.425 also and a screen-grid valve, the S.410. Additions to the 6-volt series include a new screen-grid valve, the

Mullard S.4.V.—a new 5-pin indirectly heated screen-grid valve.

S.610, and the return of the L.S.6A, which was for a time withdrawn. The characteristics of the last valve are A.C. resistance, 1,300 ohms, and amplification factor 3. Its maximum working H.T. is 400 volts. A range of A.C. valves and full- and half-wave rectifiers will be shown on their stands (Nos. 79 to 84).

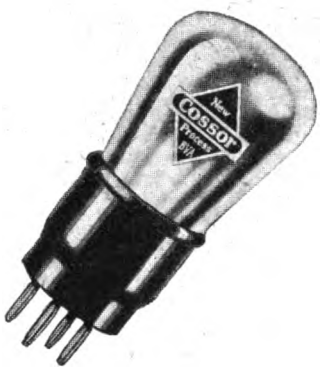
Since these valves appear, also, in the Osram list, they will be exhibited on stands 85 to 90 inclusive.—The General Electric Co., Ltd.

Cosmos, B.T.H. and Ediswan valves are now being marketed by the Edison Swan



Trio of "Mazda" valves. On the left the S.G.215, centre H.210, and right the Pen 230.

Electric Co., Ltd., and specimens of those types which will be retained under the new organisation are to be shown on stands Nos. 148 to 153 inclusive. A new range, under the name of "Mazda," have been introduced, and the 2-volt series were reviewed in this journal in the issue of August 28th last. Full details of the composition of the 4-volt series have not come to hand, but we understand that a new 4-volt pentode is now ready and will be exhibited. A full range of 6-volt valves will be shown, and this will include three power valves, the P.625A, P.625B, and P.P.3/425, the last mentioned having somewhat similar characteristics to the familiar B.T.H. B.12, and will deliver an



The new Cossor valve in the three-electrode series.

undistorted power output of three watts.

A high-voltage half-wave rectifier, U.65/550, and similar to the B.T.H. R.H.I., will be shown, as well as a varied display of A.C. indirectly heated valves.

The Cossor series have acquired some interesting additions, which will be shown on Stands 78, 138, 173 and 174. In all, about thirty-five different types will be available for the coming season. The principal new valves are the M.S.G.41, a screen-grid valve, the 41M R.C., 41M H.F., 41M L.F., 41 M.P., and 41 X.P. All of these are indirectly heated A.C. valves and require 4 volts at 1 amp. for the heater. There will be, also, a full range of half- and full-wave rectifiers operating from 250 volts to 1,200 volts R.M.S. and dissipating from 10 to 65 watts, according to type.

Visit Stands Nos. 38 and 39 and Inspect the following

WIRELESS WORLD RECEIVERS

"THREE VALVE 'KIT' SET." "THE NEW KILO-MAG FOUR."

"THE RECORD III." "THE FOREIGN LISTENER'S FOUR."

The MEGAVOX D.C. ELIMINATOR will also be available for inspection.

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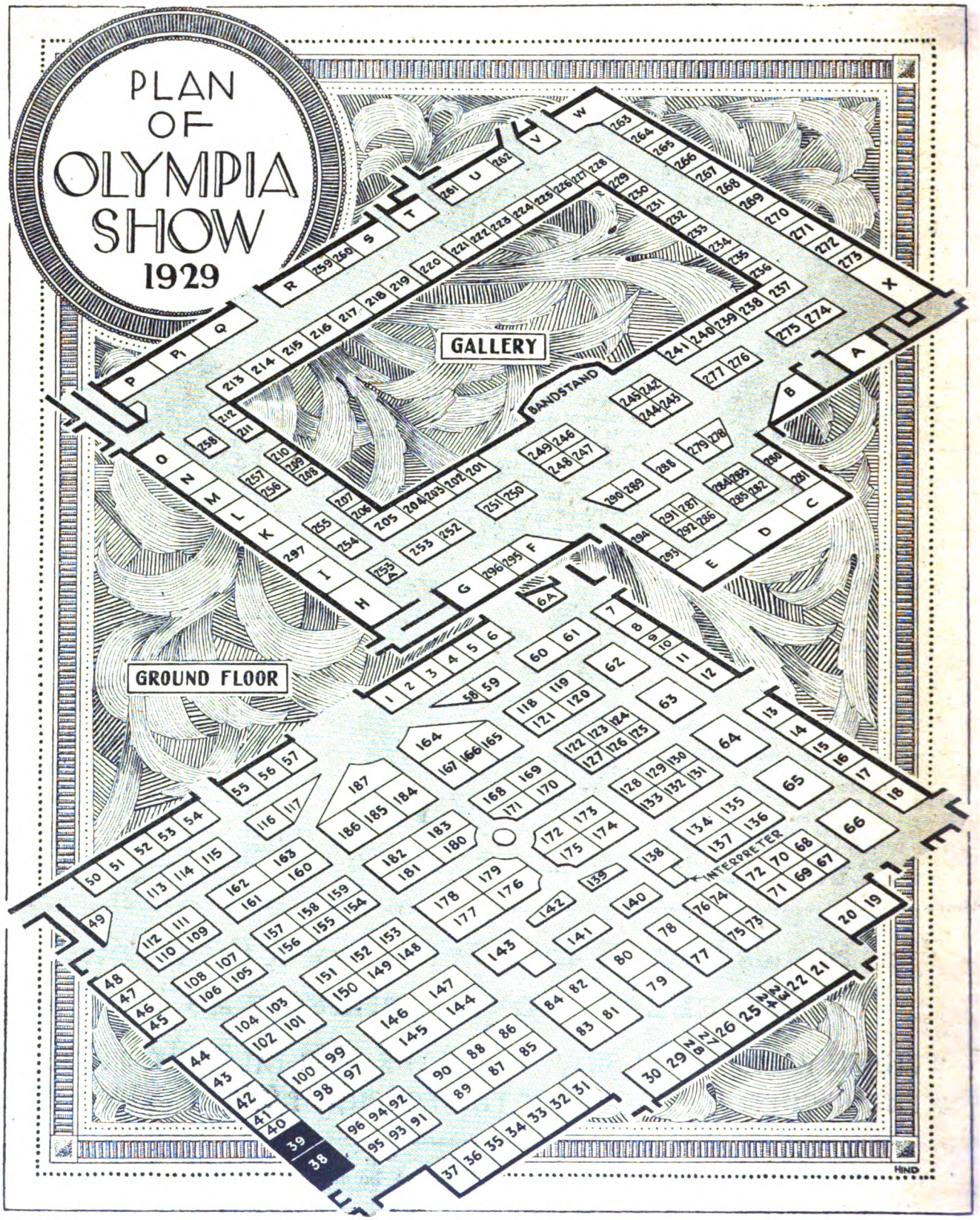

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EXHIBITORS AT OLYMPIA

FOR PLAN OF STANDS SEE FACING PAGE.

ADEY Radio, Ltd., (297)
99, Mortimer St., Regent St., London, W.1.
Aeonic Radio, Ltd., (73)
90, Regent St., London, W.1.
Atalanta, (234)
1-3, Brixton Rd., London, S.W.9.
Automatic Coil Winder & Electrical Equip. Co., Ltd., (220)
Winder House, Rochester Row, London, S.W.1.

B.B.C., (253a)
Savoy Hill, Strand, London, W.C.
B. & J. Wireless Co., (233)
2-4, Athelstane Mews, Stroud Green Rd., London, N.4.
Baker, A., (23)
89, Selhurst Rd., South Norwood, London, S.E.25.
Bakelite, Ltd., (255)
68, Victoria St., London, S.W.1.
Beaver Electrical Supply Co., (287)
5, Great Chapel St., London, W.1.
Bedford Electrical & Radio Co., Ltd., (45)
22, Campbell Rd., Bedford.
Belling & Lee, Ltd., (263 & 264)
Queensway Works, Ponders End, Middlesex.
Benjamin Electric, Ltd., (31)
Brantwood Works, Tariff Rd., Tottenham, London, N.17.
Bird & Sons, Ltd., Sydney S. (155)
Sarnesfield Rd., Enfield Town.
Bowyer-Lowe Co., Ltd., The (130 & 131)
Radio Works, Letchworth, Herts.
British Ebonite Co., Ltd., (21)
Nightingale Rd., Hanwell, London, W.7.
British General Mfg. Co., Ltd., (107)
Brockley Works, Brockley, London, S.E.4.
British Radio Gramophone Co., Ltd., (156 & 157)
77, City Rd., London, E.C.1.
Brown Bros., Ltd., (34 & 35)
Great Eastern St., London, E.C.2.
Brown, Ltd., S. G., (213, 214 & 215)
Western Av., North Acton, London, W.3.
Brownie Wireless Co., of Great Britain, Ltd., (143)
Nelson Street Works, Mornington Crescent, London, N.W.1.
Bulgin & Co., A. F., (295 & 296)
9-11, Cursitor St., Chancery Lane, London, E.C.4.
Bullphone, Ltd., (60)
38, Holywell Lane, London, E.C.2.
Burndept Wireless (1928), Ltd., (144, 145, 146 & 147)
Eastnor House, Blackheath, London, S.E.3.
Burne-Jones & Co., Ltd., (125)
288, Borough High St., London, S.E.1.
Burgoyne Wireless, Ltd., (50 & 51)
34a, York Rd., King's Cross, London, N.1.
Burton, C. F. & H., (36 & 37)
Progress Works, Bernard St., Walsall.

CARRINGTON Mfg. Co., Ltd., (270 & 271)
Camco Works, Sanderstead Rd., Croydon.
Catesbys, Ltd., (3 & 4)
Tottenham Court Rd., London, W.1.
Celestion, Ltd., (180 & 183)
London Rd., Kingston-on-Thames.
Chloride Electrical Storage Co., Ltd., (172 & 175)
217-229, Shaftesbury Av., London, W.C.
City and General Radio Co., Ltd., (256)
46, Watling St., London, E.C.4.
Cleartron (1927), Ltd., (22)
21, Cumberland St., Birmingham.
Climax Radio Electric, Ltd. (91 & 92)
Haverstock Works, Parkhill Rd., Hampstead, London, N.W.3.
Cole, Ltd., E. K., (8, 9, 10 & 11)
"Ekco" Works, London Rd., Leigh-on-Sea.
Colvern, Ltd., (99)
Mawneys Rd., Romford, Essex.
Columbia Graphophone Co., Ltd., (94 & 96)
92, Clerkenwell Rd., London, E.C.1.
Cook's Wireless Co., Ltd., (223)
C.W.C. Works, Ipswich, Suffolk.
Cossor, Ltd., A. C., (173, 174, 138 & 78)
Cossor House, Highbury Grove, London, N.5.

D.X. Coils, Ltd., (262)
542, Kingsland Rd., London, E.8.
Danipad Rubber Co., Ltd., (219)
5 & 7, Market St., Finsbury, London, E.C.2.
Day, Ltd., Will, (7)
19, Lisle St., London, W.C.2.
De la Rue & Co., Ltd., Thos. (260)
90, Shernall St., Walthamstow, London, E.17.
Dew & Co., A. J., (26, 27 & 28)
33-34, Rathbone Place, London, W.1.
Dibben & Sons, Ltd., Wm., (65 & 15)
80, St. Mary's Rd., Southampton.
Donotone (Regd.) Loud Speaker, The (268 & 269)
40, Furnival St., London, E.C.4
Dubilier Condenser Co. (1925), Ltd., (181 & 182)
Ducon Works, Victoria Rd., North Acton, London, W.3.
Dulcetto-Polyphon, Ltd., (278)
2-3, Newman St., London, W.1.
Dunham, C. S., (47 & 48)
Elm Works, Elm Park, 131, Brixton Hill, London, S.W.
Dyson & Co. (Works), Ltd., J. (1)
5, Godwin St., Bradford.

EAGLE Engineering Co., Ltd., (77)
Eagle Works, Warwick.
Eastick & Sons, J. J., (272 & 273)
118, Bunhill Row, London, E.C.1.
East London Rubber Co., (274 & 275)
Great Eastern St., London, E.C.2.
Econasign Co., Ltd. (238)
137, Victoria St., London, S.W.1.
Edison Bell, Ltd., (116)
Edison Bell Works, Glengall Rd., London, S.E.
Edison Swan Elec. Co., Ltd., (148, 149, 150, 151, 152 & 153)
(Metro Vick Supplies, British Thomson-Houston Co., Ltd.)
123, Queen Victoria St., London, E.C.4.
Ellison & Hillman, (29 & 30)
123-5, Albion St., Leeds.
Epoch Radio Mfg. Co., (218)
25, Laurence Pountney Lane, London, E.C.4.
Every Ready Co. (G.B.), Ltd., (139 & 142)
Hercules Place, Holloway, London, N.7.

FALK Stadelmann & Co., Ltd., (279)
83-93, Farringdon Rd., London, E.C.1.
Fellows Mfg. Co., Ltd., (32 & 33)
Cumberland Av., Park Royal, London, N.W.
Ferranti, Ltd., (74 & 76)
Hollinwood, Lancs.
Flinders (Wholesale), Ltd., (282)
East Stockwell St., Colchester.
Formo Company, (72)
Crown Works, Cricklewood Lane, London, N.W.
Fuller Accumulator Co. (1926), Ltd., (75)
Woodland Works, Chadwell Heath, Essex.

GAMAGE, Ltd., A. W., (258)
128, Holborn, London, E.C.
Gambrell Radio, Ltd., (62)
Buckingham House, Buckingham St., Strand, London, W.C.2.
Garnett, Whiteley & Co., Ltd., (63)
"Lotus" Works, Broadgreen Rd., Liverpool.
General Electric Co., Ltd., (85, 86, 87, 88, 89 & 90)
Magnet House, Kingsway, London, W.C.2.
Goldsman, J. L., (280)
4, Great Queen St., Kingsway, London, W.C.
Graham & Co., R. F., (230)
45 & 47, Cambridge Rd., Kingston-on-Thames.
Graham Amplion, Ltd., (164 & 187)
25-6, Savile Row, Regent St., London, W.1.
Graham Farish, Ltd., (140 & 141)
17, Masons Hill, Bromley, Kent.
Gramo-Radio Amplifiers, Ltd., (247)
1a, New London St., London, E.C.3.
The Gripso Co. (L. H. Reid & Co.), (227)
32, Victoria St., London, S.W.1.
Grosvenor Battery Co., Ltd., (237)
2-3, White St., Moorgate, London, E.C.2.

HALCYON Wireless Co., Ltd., (168 & 171)
313-319, Regent St., London, W.1.
Hardyson Radio, Ltd., (158)
13, Market St., Huddersfield.
Harlie Bros., (277)
Balham Rd., Lower Edmonton, London, N.9.

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Exhibitors at Olympia.—

Hart Accumulator Co., Ltd., (289)
35, Marshgate Lane, Stratford, London, E.15.

Hart Bros. Electrical Mfg. Co., Ltd., (239)
4, Queensway, Ponders End, Mddx.

Hart Collins, Ltd., (49)
38a, Bessborough St., London, S.W.1.

Henderson & Co., Ltd., W. J., (201)
351, Fulham Rd., London, S.W.10.

Hobday Bros., Ltd., (252 & 253)
21-27, Great Eastern St., London, E.C.2.

Houghton-Butcher (G.B.), Ltd., (242, 243, 88-89, High Holborn, Lon- 244 & 245)
don, W.C.1.

Hunt, Ltd., A. H., (259)
H.A.H. Works, Tunstall Rd., Croydon.

Huntly, Norman, (235)
35, Clerkenwell Green, London, E.C.1.

IGRANIC Electric Co., Ltd., (161 & 162)
147, Queen Victoria St., London, E.C.4.

Iliffe & Sons, Ltd., (38 & 39)
Dorset House, Tudor St., London, E.C.4.

Inc. Radio Society of Great Britain, (285)
53, Victoria St., London, S.W.1.

Itonia Gramophone, Ltd., (286)
Itonia House, 58, City Rd., London, E.C.1.

J.R. Wireless Co., (266)
6-8, Rosebery Av., London, E.C.

Jackson Bros., (97)
72, St. Thomas St., London, S.E.1.

Jewel Pen Co., Ltd., (267)
21-22, Great Sutton St., London, E.C.1.

Junit Mfg. Co., Ltd., (207)
2, Ravenscourt Sq., London, W.6.

"K.N." Electrical Products, Ltd., (254)
5 & 7, Singer St., Tabernacle St., Finsbury, London, E.C.2.

Kalisky (Aldgate), Ltd., S., (24 & 25)
75, Aldgate High St., London, E.1.

Kolster-Brandes, Ltd., (176, 177,
Cray Works, Sidcup, Kent. 178 & 179)

LAMPLUGH, Ltd., S. A., (126 & 127)
Kings Rd., Tyseley, Birmingham.

Langham Radio, Ltd., (59)
Exhibition Works, Wembley.

Lectro-Linx, Ltd., (261)
254, Vauxhall Bridge Rd., London, S.W.1.

Lever (Trix), Ltd., E. J., (211 & 212)
8-9, Clerkenwell Green, London, E.C.1.

Lissen, Ltd., (184, 185 & 186)
Friars Lane, Richmond, Surrey.

Lithanode Co., Ltd., (232)
190, Queen's Rd., Battersea, London, S.W.

Lock, Ltd., W. & T., (202 & 203)
St. Peter's Works, Bath.

Lock-Atkinson Wireless, (257)
95, Great Titchfield St., London, W.1.

Loewe Radio Co., Ltd., (291)
4, Fountayne Rd., Tottenham, London, N.15.

London Electric Stores, Ltd., (293 & 294)
9, St. Martin's St., Leicester Sq., London, W.C.

London Electric Wire Co., & (64)
Smiths, Ltd.,
7, Playhouse Yard, Golden Lane, London, E.C.1.

London Metal Warehouses, Ltd., (222)
Hill St., Pocock St., Blackfriars, London, S.E.

London Radio Mfg. Co., Ltd., (112)
Station Rd., Merton Abbey, London, S.W.19.

M.P.A. Wireless Ltd., (165)
62, Conduit Street, London, W.1.

McMichael, Ltd., L., (101 & 103)
Wexham Rd., Slough.

Mainten Mfg. Co., Ltd., (226)
126, Portland Road, Hove.

Manufacturers Accessories Co., (236)
(1928), Ltd.,
85, Great Eastern Street London, E.C.2.

Marconiphone (79, 80, 81, 82, 83, & 84)
Co., Ltd.,
210-212, Tottenham Court Rd., London, W.1.

Mic Wireless Co., (56)
White Horse Place, Market St., Wellingborough.

Montague Radio Inventions (52, 53, & 54)
& Development Co.,
117-119, Regent St., London, W.1.

Mullard Wireless (134, 135, 136,
Service Co., Ltd., 137, 58 & 117)
Mullard House,
Charing Cross Rd., London, W.C.2.

NEW London Electron Wks., Ltd., (67)
East Ham, London, E.6.

OLDHAM & Son, Ltd., (68 & 70)
Denton, Manchester.

Ormond Eng. Co., Ltd., (118 & 121)
Ormond House, Rosebery Av., London, E.C.

PANDONA, Ltd., (225)
87-89, Edmund St., Birmingham.

Paroussi, E., (206)
10, Featherstone Buildings London, W.C.1.

Partridge & Mee, Ltd., (98)
74, New Oxford Street, London, W.C.1.

Partridge, Wilson & Co., (283)
217a, Loughborough Rd., Leicester.

Perfectavox, Ltd., (114)
Alexandra Works, High St., Yeadon, near Leeds.

Peto & Radford, (108)
50, Grosvenor Gardens, London, S.W.1.

Peto Scott Co., Ltd., (42, 43, & 44)
77, City Road, London, E.C 1.

Philips Radio, (169 & 170)
145, Charing Cross Rd., London, W.C.

Prowse & Co., Ltd., Keith, (228)
159, New Bond St., London. W.1.

Pye Radio, Ltd., (160 & 163)
Paris House, Oxford Circus, London, W.1.

READY Radio, Ltd., (93)
159, Borough High St., London, S.E.1.

Radielle Co., Ltd., (2)
18a, Haverstock Hill, Chalk Farm, London, N.W.3.

Radio Gramophone (292)
Development Co.,
7, St. Peter's Place, Broad St., Birmingham.

Radio Instruments, Ltd., (122, 123, & 124)
12, Hyde St., London, W.C.1.

Radio Service (London), Ltd., (204)
105, Torriano Av., Camden Town, London, N.W.5.

Redfern's Rubber Works, Ltd., (46)
Dawson St., Hyde, Cheshire.

Rees, Mace Mfg. Co., Ltd., (105)
39a, Welbeck St., London, W.1.

Regent Radio Supply Co., (16, 17, & 18)
21, Bartlett's Buildings, London, E.C.4.

Reproduction, Ltd., (55)
5-7, Dysart St., London, E.C.2.

Rolls-Caydon Sales, (166)
77, Rochester Row, London, S.W.1.

Rooke Bros., Ltd., (119)
55, Cardington St., London, N.W.1.

Royal Radio Co., (12)
4-5, Dorset Mews North, Upper Gloucester Place, London, N.W.1.

SEL-EZI Wireless Supply (105)
Co., Ltd.,
6, Greek St., London, W.1.

Selectors, Ltd., (102 & 104)
1, Dover St., London, W.1.

Selfridge & Co., Ltd., (208, 209, & 210)
Oxford St., London, W.1.

Siemens Bros. & Co., Ltd. (69 & 71)
Caxton House, Westminster, London, S.W.

Six-Sixty Radio Co. (288)
(The Electron Co., Ltd.),
122, Charing Cross Rd., London, W.C.2.

Standard Wet Battery Co., (57)
184, Shaftesbury Av., London, W.C.

Stratton & Co., Ltd., (109)
Balmoral Works, Bromsgrove St., Birmingham.

Sun Electrical Co., Ltd., (250 & 251)
118-120, Charing Cross Rd., London, W.C.

Swift Levick & Sons, Ltd., (240)
Clarence St. Works, Sheffield.

Sylvex, Ltd., (231)
144, Theobalds Rd., London, W.C.1.

Symphony Gramophone & (129 & 132)
Radio Co., Ltd.,
Axtell House, 23-24, Warwick St., Regent St., London, W.1.

TELEGRAPH Condenser Co., (248)
Ltd.,
Wales Farm Rd., North Acton, London, W.3.

Telsen Electric Co., Ltd., (110)
207, Aston Rd., Birmingham.

Tonex Co., The, (265)
Walker St., Blackpool, Lancs.

Trelleborg Ebonite Works, Ltd., (281)
Union Place, Wells St., London, W.1.

Truphonic Radio, Ltd., (167)
Truphonic House, Hanover Park, Peckham, London, S.E.

Tulsemere Mfg. Co., (276)
1-7, Dalton St., West Norwood, London, S.E.27.

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Exhibitors at Olympia.—

Turner & Co., (95)
54, Station Rd., New Southgate, London, N.11.

ULTRA Electric, Ltd., (106)
661, Harrow Rd., London, N.W.10.

Universal Gramophone & Radio Co., Ltd., (100, 40 & 41)
Ryland Road, Kentish Town, London, N.W.5.

VANDERVELL & Co., Ltd., (120)
C. A.,
Warple Way, Acton, London, W.3.

Varley (Oliver Pell Control), (154 & 159)
Kingsway House, 103, Kingsway, London, W.C.

Voltron Co., Ltd., (217)
Queensway, Ponders End, Middlesex.

WARD & Goldstone, Ltd., (290)
Frederick Rd., Pendleton, Manchester.

Watmel Wireless Co., Ltd., (111)
Imperial Works, High St., Edgware, Middlesex.

Webb Condenser Co., (284)
42, Hatton Garden, London, E.C.1.

Westinghouse Brake & Saxby Signal Co., Ltd., (13 & 14)
82, York Rd., King's Cross, London, N.

Whiteley, Boneham & Co., Ltd., (66)
Nottingham Rd., Mansfield, Notts.

Whittingham, Smith & Co., (113)
"Portadyne" Works, Chase Estate, Park Royal, London, N.W.

Wilkins & Wright, Ltd., (115)
Utility Works, Holyhead Rd., Birmingham.

Williams & Moffat, Ltd., (229)
Ladypool Rd., Sparkbrook, Birmingham.

Wingrove & Rogers, Ltd., (128 & 133)
Arundel Chambers, 188-9, Strand, London, W.C.

The Wireless World, (38 & 39)
(Iliffe & Sons, Ltd.),
Dorset House, Tudor Street, London, E.C.4.

Wright & Weaire, Ltd., (221)
740, High Rd., Tottenham, London, N.17.

YAGERPHONE, Ltd., (6)
28, Charlotte St., London, E.C.2.

D.F. NEEDED.

Don't visit Olympia without your direction finder—*The Wireless World.*

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PROOF OF THE PUDDING.

For the first time in the history of British wireless shows it will be possible at Olympia this year to listen to sets in operation. Twenty-four soundproof cabinets will be situated in the gallery.

o o o o

PARIS P.T.T.

A new broadcasting station of the French Post Office, Paris P.T.T., has been put into service with a power of 5 kilowatts. Transmissions take place daily between 4 and 10 p.m.

o o o o

RUSSIA'S LESSON FOR BRITAIN.

The encouragement given to amateur transmitters by the Soviet Government is resulting in a big increase in amateur licences in Russia. The number now exceeds 500.

o o o o

BURNDEPT REDIVIVUS.

Profits of £15,979 over a period of ten months ending June 30th, 1929, are recorded by Burndept Wireless (1928), which is able to pay a dividend at 6 per cent. per annum—the first return to be made to the original shareholders.

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THE FARTHEST NORTH!

A Soviet expedition claims the honour of having erected the world's most northerly wireless station. This has been established at Tranquil Bay, Franz Josef Land. The station will be used principally for meteorological reports, operating on a wavelength of 43 metres.

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OLYMPIA SHIPPING EXHIBITION.

Several devices of wireless interest are on view at the 10th Shipping, Engineering and Machinery Exhibition, which opened at Olympia on Thursday last and runs until September 28th. An example of the automatic alarm receiver is shown, and another noteworthy device is the Laryngaphone noise-excluding telephone, which enables conversations to be carried on without interruption from the noisiest engine room. The microphone of the instrument is applied to the neck or cheek of the speaker, being actuated by the vibrations of the vocal chords.

CURRENT TOPICS.

EVER OPEN DOOR.

The Transatlantic Telephone services to Canada, U.S.A., Mexico and Cuba are now open continuously day and night.

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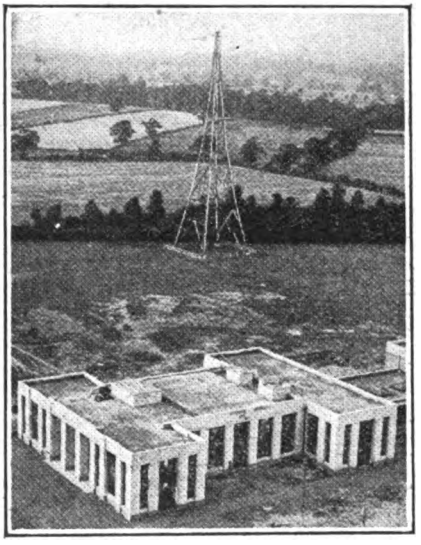
WIRELESS DISPLACES PIGEONS.

The American Navy's collection of specially-trained carrier pigeons has been "demobilised" owing to the perfecting of radio communication.

o o o o

A CALL FROM MEXICO.

The Trens News Service, of Mexico City, addresses the world in a circular letter requesting all wireless users to pick up their news report broadcast in Morse daily at 9.45 p.m. (G.M.T.) on 16 metres. The power is 20 kilowatts.



A MASTHEAD VIEW of the new London Regional broadcasting station now engaged on nightly tests.

WIRELESS ON GERMAN BUSES.

The suburban 'bus services of Berlin are to experiment with the introduction of broadcast receivers and loud speakers on 'buses which take passengers into the surrounding country.

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"INDEPENDENT" SHOW IN PARIS.

Running concurrently with the National Radio Exhibition at Olympia will be the Paris International Wireless Show, extending from September 27th to October 13th. The show is "forbidden ground" to members of the French Radio Manufacturers' Association, the 150 exhibitors consisting of independent firms and foreign manufacturers.

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THE CABLE WIRELESS MERGER.

Imperial and International Communications, Ltd., is the name of the new company which will undertake the wireless and cable traffic work of the cable-wireless merger. The manufacturing side of the merger will be under the control of Cable and Wireless, Ltd., The two organisations will have capital interests exceeding £53,000,000.

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TRANSMISSIONS ON 7 CENTIMETRES.

Experiments in transmission on wavelengths as short as 7.12 and 19 centimetres have recently been conducted by Professor Protoff, of the Soviet State Laboratory at Nijni-Novgorod. According to the Russian radio journals, Prof. Protoff's signals have been heard clearly at distances of several thousand miles with a transmission power of only 20 watts.

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ATTACK ON FRENCH RADIO FIRMS.

The popularity of three- and four-valve sets in Great Britain and Germany has provoked a discussion in France as to why that country still favours "super-sets" of the six- seven- and eight-valve variety, writes our Paris correspondent. The widely-held view that multi-valve sets are necessary in view of the lack of good broadcasting stations is contested by "Petit Radio," a semi-official organ of the Post Office, which assigns a commercial cause to the existing "stagnation," alleging that manufacturers continue to

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produce complex receivers to induce the public to pay high prices in the belief that simple sets are worthless.

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MOTOR CO. INVADES RADIO FIELD.

According to a New York report, General Motors Corporation intends to retail radio goods by arrangement with the Radio Corporation of America.

NIGHTINGALE TELLS THE WORLD.

An enterprising member of the staff of PCJ, Hilversum, was opening the studio window to admit fresh air at the end of a recent programme, when he heard the full-throated song of a nightingale singing not far away. Taking in the situation immediately, he ran to the microphone and announced in six different languages that PCJ was about to broadcast the bird's song. The microphone was silently wheeled to the window, and for some time five continents heard the nightingale singing. World-wide reports received by Philips Lamps, Ltd., showed the broadcast was one of the most perfect of its kind ever attempted.

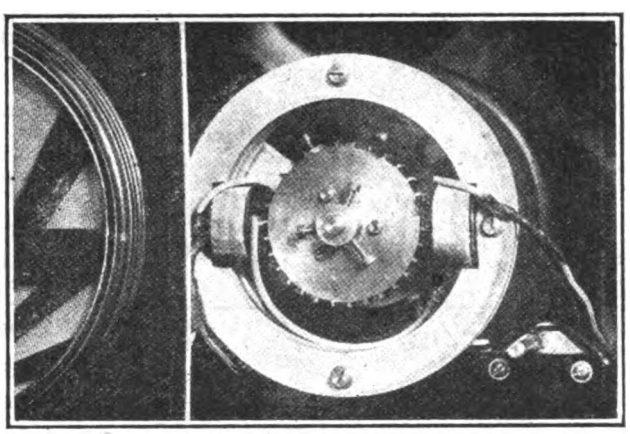
PCJ now transmits on a wavelength of 31.4 metres, and with a power of 24 kW. on Thursdays, Fridays and Saturdays.

TELEVISION FROM 2LO.

Baird Synchronising System Described.

NEGOTIATIONS which have been in progress for more than a year between the Post Office, the B.B.C., and the Baird Television Development Co., Ltd., have now culminated in the introduction of an experimental service. "In granting these facilities," states the B.B.C., "in which the public can, if they so desire, take part, neither the Postmaster-General nor the B.B.C. accept any responsibility for the quality of the transmission or the results obtained." No such words of caution can stay the activities of the radio enthusiast who has long looked forward to television as a fascinating field of experiment, and to whom almost any results, however crude, would be of interest and would amply repay for the time and trouble expended in investigating the possibilities. Nothing could be more unfortunate than the fact that the coming transmissions are to take place between 11.0 and 11.30 a.m. daily, Saturdays and Sundays excepted. Such a schedule will prove so serious a setback to amateur activity that the outcome by way of gauging the public attitude towards its innovation will be at the least misleading.

There are many difficulties, however, which stand in the way of a universal interest in television broadcast. Foremost is the absence of receiving apparatus, while the secrecy, perhaps wisely enforced, which has surrounded the Baird system has rendered it impossible for the amateur to throw in his support by way of proceeding with the making up of suitable experimental gear. For more than a quarter of a century inventors have applied themselves to the problems of television, and in every case they have encountered an insurmountable barrier in the devising of means for synchronising the rotating parts at transmitter and receiver. None of the systems of which details have been disclosed has shown a solution to the problem, and a cloud of prejudice has descended upon the Baird apparatus in the absence of technical details of the method of synchronising to be used. It is in respect of the synchronising gear that the public's judgment on the success of the system would be based. Demonstrations in themselves are not entirely satisfying, as the conditions may be very different from those under which the apparatus is to be finally used.



This interesting illustration shows for the first time the phonic wheel synchroniser used in the Baird equipments. It is controlled by a break in the continuity of the picture signal following every traverse of the light spot across the aperture.

Phonic Wheel Inter-line Synchronising.

Now that the apparatus is about to be available to the public we are able to describe the method of synchronising fitted to the Baird equipments. The aim is to provide for the rotation of a disc with a degree of constancy that after long periods of running must possess no cumulative error. In the Baird apparatus we find that this aim is accomplished by the phonic wheel method. A toothed wheel is mounted on the motor shaft which, in rotating before an electromagnet, allows of the passage of the teeth past the magnet poles in unison with interposed current impulses sent out by the transmitting equipment. A standard of picture analysis has been decided upon whereby the image is built up by the assembly of thirty transverse lines. Each line is a travelling light spot of varying intensity, and it is between each traverse or each line of the picture that the synchronising signal takes charge of the rotating toothed wheel. This method has been referred to as "inter-line synchronising" in this journal, wherein it was first described.[1] Baird apparatus adopts a synchronising signal in the form of a break in the continuity of the current forming the picture. It will be seen that the teeth of the wheel can pass unrestricted before the poles of the electromagnet only in the absence of a picture forming current. In the simple form of receiver the rectified signals, obtained in a manner similar to that adopted in picture reception, are passed to a neon lamp together with the synchronising magnet, these two components being series connected. It is stated that the receiving disc is arranged to run slightly slower than the analyser at the transmitter, so that the phonic motor actually accelerates the motor drive, so bringing the disc into step on the completion of each line or each traverse of the picture. A thirty-hole disc, therefore, requires a toothed wheel carrying thirty poles. Neon tubes for use with television receivers and capable of working with the potentials normally available from D.C. and A.C. mains eliminators are used in the Baird equipment.

Although laboratory demonstrations of the apparatus have been witnessed by many readers, a few facts as to the results may help others to clearly appreciate the degree of success at present obtainable. The image is viewed through a magnifier and possesses a slight, yet not tiring, flicker. Good brilliance is obtained, but with an excessive contrast between light and shade. A sitter at the transmitter is at once recognised, and his expressions considerably enhance his words which come from an adjoining loud speaker. With a little concentration one can note the time from a normal watch. Letters running past the transmitter in the manner of an advertising sign are clear cut and easily followed. These results, it is stated, will be obtainable on home equipments working on the broadcast service.

[1] *The Wireless World*, July 3rd, 1929, p. 8.

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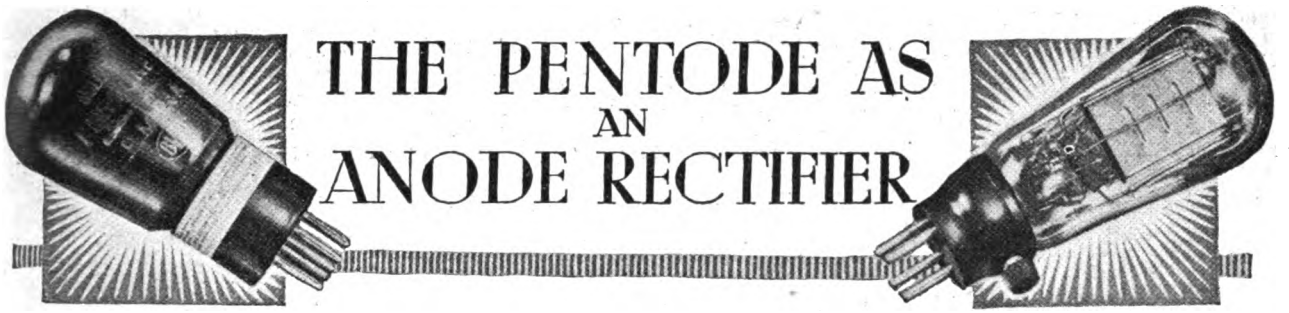

THE PENTODE AS AN ANODE RECTIFIER

High Sensitivity and Large Output.

By A. L. M. SOWERBY, M.Sc.

IN the instructions issued with the Mullard P.M.22 valve (2-volt pentode) there is included the warning: "This valve should be used only in the output stage of a receiver and not in intermediate stages." It will, of course, be realised that this instruction is a direct challenge to all right-minded experimenters to find out what kind of a performance the valve will put up in other directions. In view of the many difficulties that arise in connection with the detector valve of a receiver, and of the fact that the use of the pentode has already been suggested as a possible cure for some of these troubles,[1] the present article is devoted to its behaviour in that direction, and includes a number of measurements made in endeavouring to estimate its worth for that purpose.

Detector stages in which the valve rectifies by virtue of the bend in its grid volts anode current characteristic (anode bend rectification) may be divided into two distinct classes. First, there is the older design in which the anode circuit of the valve is completed through a resistance as in Fig. 1. The outstanding feature of this circuit is its high sensitivity to small signal inputs, with the usual corollary that it will not accept a large input unless it is supplied with an unusually high anode voltage. The valve used is always one of high amplification factor, and hence also of high A.C. resistance.

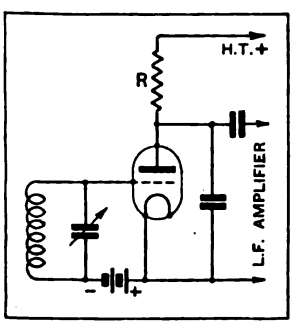

Fig. 1.—Resistance-coupled detector. Uses a high-resistance valve, and is sensitive to weak signals, but cannot deal with really strong signals.

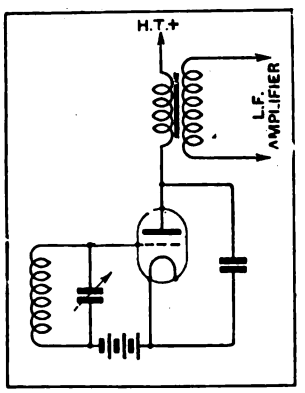

Fig. 2.—Transformer-coupled detector. Uses a low-resistance valve, is insensitive to weak signals, but rectifies strong signals very efficiently.

It is not possible, unless the requirements of quality in reproduction of music are to be thrown overboard altogether, to use a valve of this type to precede a transformer in the circuit of Fig. 2, for the naturally high A.C. resistance of the valve is raised to even higher values by the application of the negative grid-bias used to adjust it for rectification. With the adoption of the transformer we are therefore compelled to employ a valve of different type altogether, choosing one that, with the grid-bias required for rectification, will have, under working conditions, an A.C. resistance somewhere near that which gives the best compromise between effective amplification and quality of reproduction. In practice, and with a first-class transformer, this condition is found to be met by choosing a valve of nominal A.C. resistance about 10,000 ohms or a little less, and with as high an amplification factor as so low a resistance will permit. The detector stage resulting from this combination of valve and transformer is not particularly sensitive to small signal inputs, but will accept, without overloading, a much larger input than can be applied to the resistance-coupled detector. When this input is available a much greater output of rectified signals can be obtained, and for this reason this style of design is in many cases the better alternative.

Sensitivity to Small Inputs.

The A.C. resistance of the P.M.22 is some 65,000 ohms, which brings it into the class of valves suitable for use as a rectifier when followed by a resistance; as its amplification factor is 82 one would expect it to be a sensitive rectifier, responding well to quite small inputs of signals, for the general rule is that the higher the amplification factor of the valve the smaller the signal-voltage required to enable it to give an L.F. output of reasonable magnitude and good quality. Following up this idea, the performance of the P.M.22 as an anode rectifier was investigated, the operating conditions being varied to a considerable extent in different experiments.

In studying the capabilities of a valve for any particular purpose its characteristic curves must serve as the starting-point. In the case of the pentode the curves are considerably complicated by the presence

[1] *The Wireless World*, May 22nd, 1929, page 527.

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The Pentode as an Anode Rectifier.—

of one more electrode than is present in the ordinary triode—one more *accessible* electrode, that is to say. A triode provides a family of curves, each representing the plate current corresponding to a number of different plate voltages at a fixed value of grid voltage; with the pentode one requires, for the fullest information, a complete family of this kind for every different auxiliary grid (" terminal ") voltage. Such a complete set of pentode curves would fill at least three pages of *The Wireless World*, which amply accounts for the fact that the full set has not yet been published; nor do they accompany this article.

The plate current of the pentode is controlled by three factors: the voltage applied to the plate itself.

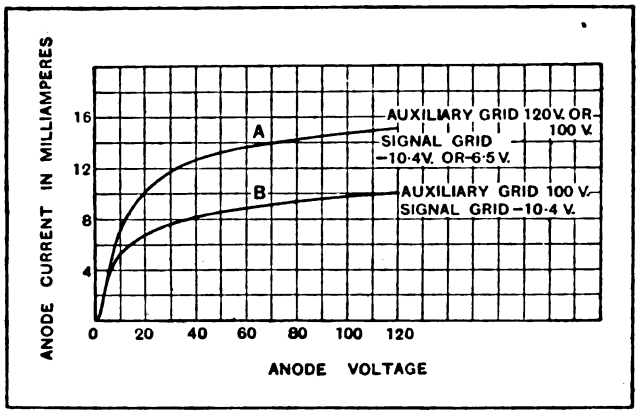

Fig. 3—Anode voltage/anode current curves of Mullard 2-volt pentode P.M.22.

the grid-bias in use, and the voltage on the auxiliary grid. Of these three factors the plate voltage is the least important, and has the smallest effect in deciding the magnitude of the plate current, as can be seen by comparing the two curves of Fig. 3. Curve A is the plate voltage/plate current curve of the P.M.22 valve with a grid-bias of 10.4 volts and with 120 volts on the auxiliary grid. It will at once be noticed that for anode voltages greater than about 50 the change in plate current brought about by altering the plate voltage is only a small proportion of the total current.

Curve B shows the same relationship with 100 volts instead of 120 volts on the auxiliary grid, and with the inner (signal) grid at the same potential as in curve A. The vertical distance between the two curves is seen to be large, showing the considerable influence of the auxiliary grid voltage on the magnitude of the plate current. Expressing it numerically, one can deduce from the two curves that one additional volt on the auxiliary grid has as great an effect in increasing the plate current as some ten extra volts on the anode itself. This is an exact parallel to an ordinary valve of amplification factor 10, where a grid voltage change of one volt would alter the plate current to the same extent as a plate voltage change of ten volts. We may say, in fact, that the amplification factor between auxiliary grid and plate in the P.M.22 is ten.

The inner grid of the pentode exercises an even greater effect on the plate current than does the auxiliary grid. When obtaining the results plotted in the curves of Fig. 3 it was found that by changing the potential of the inner grid from its original value of 10.4 volts to 6.5, curve B could be shifted up to coincide exactly with curve A, the auxiliary grid being still kept at 100 volts. Thus a change of 3.9 volts on the inner grid is equivalent, so far as plate current is concerned, to a change of 20 volts on the auxiliary grid.

Effect of the Auxiliary Grid.

Let us see what bearing these facts have upon the suitability of the pentode as an anode rectifier coupled by a resistance, as in Fig. 1, to the succeeding valve. When a triode is used in this circuit it is so adjusted that there is a standing plate current of some 10 to 50 microamps. (1 microamp. = 1/1000th milliamp.) When signals arrive the mean effective grid voltage is raised, resulting in an increase of plate current. As the plate current increases the voltage dropped across the resistance in the plate circuit also increases, leaving less of the battery voltage available at the anode of the valve itself. In this way the anode current is prevented from rising to as large a value as it would attain if this compensating influence were not at work, for in the triode the anode voltage plays a large part in determining the plate current. In the pentode, as we have already seen, the influence of anode voltage is very much smaller, so that we might expect the change in plate current due to the arrival of a signal to be greater than with a triode. In other words, the pentode should give, for the same high-frequency input, a greater output than an ordinary valve can provide, and should, therefore, excel in sensitivity to weak signals while still being able, if necessary, to handle stronger ones without distortion.

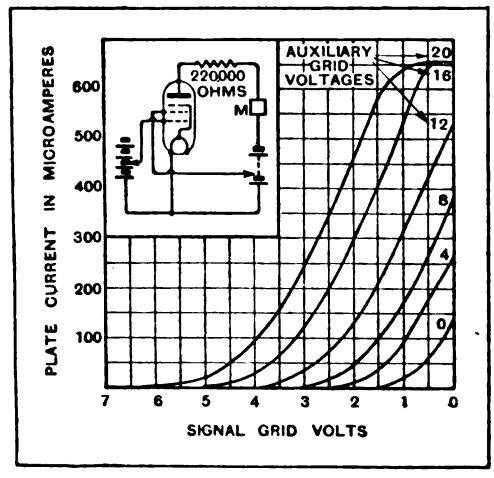

Fig. 4.—Variation of plate current with grid volts for a number of different auxiliary grid voltages. Observe " saturation " towards the top of the curves for 16 or 20 volts on the auxiliary grid.

In order to gain an idea of the best conditions under which to operate the valve as a rectifier, the anode-voltage-anode-current curves of Fig. 3 are not very helpful. A much better indication can be obtained by examining the curves found by plotting grid voltage against

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The Pentode as an Anode Rectifier.—

anode current for a constant anode voltage and various values of auxiliary grid voltage. A family of such curves, all taken with a 220,000 ohm resistance in the plate circuit and an anode battery voltage of 145 is given in Figs. 4 and 5.

From a consideration of these curves some rather interesting points emerge. In the first place it is clear that for rectification the valve must be set so as to have an initial plate current, before signals are applied, in the neighbourhood of 20 to 30 microamps. with

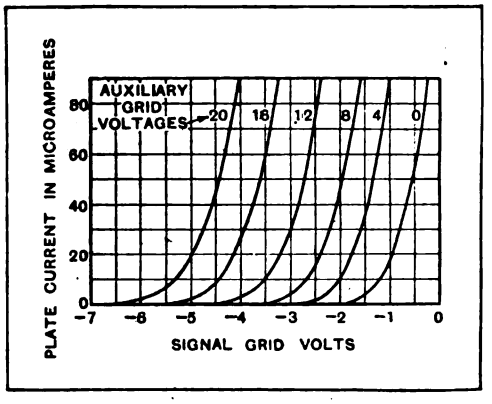

Fig. 5.—The lower end of the curve of Fig. 4 on a larger scale. The bottom bend is more sharply defined when a lower auxiliary grid voltage is used.

the anode resistance used, while from the point of view of obtaining rectification it does not much matter what combination of auxiliary grid voltage and grid-bias is chosen.

Factors Limiting Output.

The peak voltage that the valve can handle is limited in two different ways, depending on the operating conditions. If the auxiliary grid voltage and the grid-bias are both low, as in the curves to the right of Fig. 4, a large grid-swing impressed upon the valve will cause grid current to flow. In recognition of this fact the curves have not been carried into the region of positive grid potentials, since in that region grid current flows, and the curves, though they can be drawn, cannot be used in practice. In the two left-hand curves of Fig. 4 another limitation peculiar to the pentode makes its appearance. These two curves turn over sharply to the horizontal while still in the region of negative grid potentials. The current reached at the top of the curves is that which the anode battery voltage can drive through the anode resistance, and corresponds to zero voltage at the anode of the valve itself. If an attempt were made to use these curves right up to the line of zero, grid voltage distortion of an extremely unpleasant character would arise as soon as the horizontal part was entered upon. The maximum peak voltage that the valve can accommodate with the circuit conditions chosen is thus about 3 volts.

In Fig. 5 the lower portions of the same curves are repeated in order to show the character of the bottom bend upon which the process of rectification depends. On the larger scale it becomes evident that the bend in the curve is sharper at the right-hand end of the series of curves than at the left. For the reception of strong signals a grid-bias of some five volts or more would be chosen in order to ensure that grid current should not flow and that the whole of the straight part of the curve should be available without distortion arising. The comparative bluntness of the bend would make no appreciable difference to the efficiency of rectification for strong signals. In receiving weak signals, on the other hand, very noticeably greater sensitivity can be attained by taking advantage of the sharper bend in the curves at the right of the diagram, using a bias of from 1 to 1½ volts, and adjusting the voltage on the auxiliary grid for the loudest signals on a weak station. With this setting a strong signal would produce overloading of a very audible variety.

In order to obtain further data on the performance of the pentode as a rectifier, a further series of measurements was undertaken. In these high-frequency voltages of known magnitude were applied between inner grid and filament of the valve, and the change in plate current due to rectification was measured. For these experiments a comparatively low value of

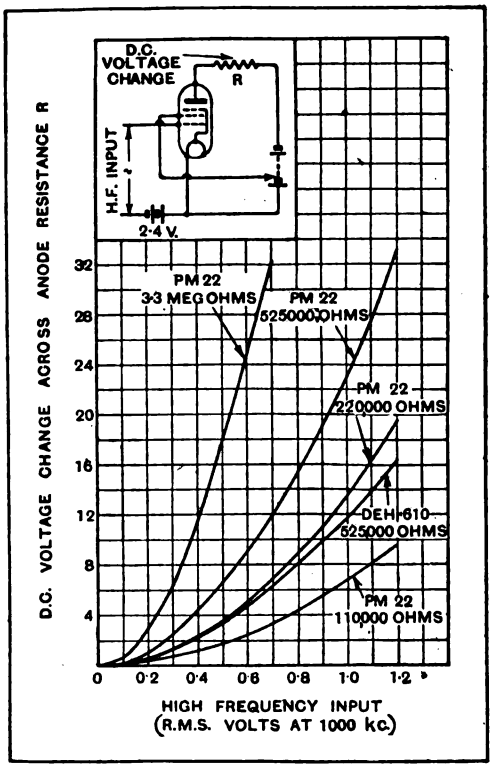

Fig. 6.—Relation between H.F. carrier voltage and D.C. voltage change across R. The steeper the curve the more sensitive the rectifier.

grid-bias was employed, as the measurements were designed as a test of sensitivity. The high-frequency input ranged up to about 1¼ volts r.m.s., at a wavelength of approximately 300 metres. The arrangement of the apparatus was such that the voltage was not affected by connecting the pentode across the source.

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The Pentode as an Anode Rectifier.—

The results are summarised in Fig. 6, in which the change in voltage across the anode resistance, obtained by multiplying the change in plate current by the value of the resistance through which it flowed, is plotted against high-frequency input. For comparison the results given by a sensitive high-resistance triode rectifier is also included.

Effect of Anode Resistance on Sensitivity.

The sensitivity of the pentode as rectifier, whether for large or small inputs, is seen to increase very rapidly as the anode resistance is raised from low to high values. This effect is present also in the case of triodes, but the gain in sensitivity achieved by choosing an anode resistance of the order of megohms is very much greater with the pentode. In either case, of course, the extra sensitivity is only attained at the cost of some loss of the highest musical notes. Comparing the pentode with the triode (a D.E.H.610 valve, $\mu = 40$, $R_0 = 60{,}000$ ohms) it is seen that the pentode, with an anode resistance of a quarter of a megohm, gives slightly greater sensitivity than the D.E.H.610 with half a megohm, while if the P.M.22 is used with half a megohm in its plate circuit it provides signals nearly twice as loud as the triode. In using a pentode in this way one is therefore enabled to make a more than usually satisfactory compromise between the rival claims of sensitivity, which necessitates a high value of anode resistance, and full reproduction of the high musical notes, which are inclined to vanish if the resistance is made too high.

The attention of those engaged in laboratory work is specially directed to the extremely high sensitivity to very small inputs that is attainable when using an anode resistance of the order of 3 megohms. As rectifier in a valve voltmeter of the two-stage type described in various text-books[2] it will respond to high-frequency voltages of less than half the amplitude of the smallest which a triode can detect.

Further data, dealing more particularly with the points that arise when incorporating the pentode in a receiver in the capacity of detector, will be given in the second part of this article.

(To be concluded.)

[2] See, for example, Hund's "Hochfrequenzmesstechnik," 2nd Edition, page 150; or *J. Sci. Instruments*, 3, p. 342 (1926).

TRANSMITTERS' NOTES AND QUERIES.

Belgian Amateurs.

The Belgian Postal Authorities have notified amateur transmitters in that country that the international prefix ON must be used with their call-signs as from August 1st.

It may be remembered that in our issue of May 22nd last we noted that some Belgian amateurs were unwilling to use this official prefix, preferring to remain faithful to the old EB.

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Call-signs for Uruguay.

Amateur transmitters in Uruguay use the international prefix CX, and their call-signs are allocated according to the various geographical departments. Thus, 1AA-9CZ are reserved for the Department of Montevideo, 1DA-9DZ to Canelones, 1EA-9EZ to San Jose, 1FA-9FZ to Colonia, 1GA-9GZ to Soriano, 1HA-9HZ to Rio Negro, 1IA-9IZ to Paysandu, 1JA-9JZ to Salto, 1KA-9KZ to Artigas, 1LA-9LZ to Florida, 1MA-9MZ to Flores, 1NA-9NZ to Duranzo, 1OA-9OZ to Tacuarembo, 1PA-9PZ to Riviera, 1RA-9RZ to Maldonado, 1SA-9SZ to Lavalleja, 1TA-9TZ to Rocha, 1UA-9UZ to Treinta y Tres, 1VA-9VZ to Cerro Largo, while portable stations are distinguished by the call-signs 1ZA-9ZZ

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The New Berne Lists.

We have now received from the International Bureau of the Telegraphic Union a copy of the Alphabetical List of Call-signs, which completes the set of volumes comprising the new "Berne List." We find we were misinformed when we stated, in our note on September 4th, that this list would contain the call-signs of all stations included in the five main lists, as it appears that those of broadcasting stations are omitted.

There should not be any great difficulty in determining to which list of particulars any individual call-sign refers, as the three-letter signs relate to land stations with a few exceptions where four-letter signs are still retained, in which case the name of the station is followed by FX, indicating that it is not a ship station (e.g., CRAF, Melange, Angola, FX). There may, however, be some confusion between Fixed and Land Stations (Part I) and Stations Performing Special Services (Part II). D.F. stations and Radio Beacons are distinguished by the words "Gonio" and "Phare" respectively, but in a few cases there is nothing to indicate whether the particulars of a station will be found in Part I or Part II (e.g., IQW, Ancona, is found among the Italian Meteorological Stations in Part II, but not among the Fixed Stations in Part I).

Ship stations are easily distinguished by having four-letter call-signs, and aircraft stations by their five-letter calls.

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QRA Wanted.

XAU8SAZ.

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Changes of Address.

G2AX	C. S. Bradley, 91, Shirley Road, Shirley, Croydon.
2AZL	W. Paylor, 25, Acre Crescent, Middleton, Leeds.

CLUB NEWS.

Clubs and the Regional Scheme.

One outcome of the regional broadcasting scheme will probably be the need for more wireless clubs to assist the "ordinary listener" to obtain the best results that the B.B.C. can give him, incidentally stimulating in him a desire to approach wireless as a fascinating hobby. The majority of clubs are now discussing plans for the winter session, and it is interesting to note that several are making it their duty to attack the oscillation bugbear.

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Non-Broadcasting Questions.

The Hackney Radio and Physical Society has resumed its meetings at the Electricity Showrooms, Lower Clapton Road, E.5, and a syllabus is in preparation. On September 30th Mr. Cole will lecture on the uses of valves and circuits otherwise than for broadcast reception.

Hon. Secretary: Mr. G. E. Sandy, 48, Melrose Avenue, Wimbledon Park, S.W.

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Meetings Twice Weekly.

The Kentish Town and District Radio Society resumed meetings on Tuesday last, September 17th, at the Carlton Road School, Kentish Town, under the chairmanship of Mr. Hembury (G6AY). New members are cordially welcomed, and full particulars regarding the Society can be obtained from the Hon. Secretary, Mr. A. H. Sartain, 40, Harrington Street, Regents Park, N.W. Meetings are held on Tuesdays and Fridays at 8 p.m.

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Constructing a Club Set.

The construction of a screen-grid set is occupying the members of the Slade Radio Society (Birmingham), and some interesting and enjoyable evenings are being spent in producing a set which shall be worthy of the Society. In the near future a direction-finding test is to be held in the open air, a suitable venue for the transmission having been chosen by an "independent" person unattached to the Society.

A party of members will visit the Olympia Radio Exhibition on September 28th. Such has been the demand for membership of the party that only a few vacancies now remain.

Full particulars regarding the Society's activities can be obtained from the Hon. Secretary, 52, St. Thomas Road, Slade Road, Birmingham.

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BROADCAST BREVITIES

By Our Special Correspondent.

Television Tests from 2LO.—Farewell to GNF.—Winter Wavelength Checking.

A Television Debut.

The Baird television broadcasts which are to be given daily from 2LO, beginning on September 30th, will, of course, be restricted to the transmission of images, no simultaneous broadcasting of speech being possible on a single frequency.

It is noteworthy that the Postmaster-General and the B.B.C. disclaim all responsibility for the results obtained; it would have been more surprising, however, if either party had declared otherwise. The transmissions are purely experimental, and at the moment it is only fair to the Baird Company to regard them as such.

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Another Spark Set to Go.

A philosopher has said that we never consciously perform an action, pleasant or unpleasant, for the last time, without a pang of regret. So it is quite likely that even those who have spent years in cursing the shrill note of GNF, North Foreland, will regain their freedom with a sigh when the station changes to ICW in about two months' time.

The sparking of GNF has probably been the first Morse signal heard by thousands of listeners in S.E. England when tuning their first wireless receiver.

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Thermometer Control in Algeria?

Have you heard an occasional heterodyne on 2LO in the last week or two? The engineers at Keston place the blame on an old offender, Algiers, which ought to be transmitting on 351 metres, but seems to have developed a habit of swinging up and down the frequency scale in tune with the thermometer.

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A Question of Power.

Talking of Keston, I hear that the move to the new receiving headquarters at Tatsfield is temporarily held up owing to a delay in the completion of the electrical power supply. It is expected, however, that the transfer will take place before the excitements of winter wireless begin, when wavelength checking becomes a really serious matter. It is generally conceded that the summer months have not severely tested the Prague Plan, but it seems more than likely that the increased radiation possible in winter will disclose some painful clashes.

Face-lifting and Broadcast Reception.

Listeners in the Oxford Street district may suffer in more than one respect when Brookman's Park supersedes 2LO. In addition to loss of signal strength it is extremely probable that they will also discover a babel of extraneous noises which were formerly overwhelmed through the proximity of a 3 kW transmitter. Electric lifts abound in the district; in fact, almost every building in the locality possesses at least one of these "mush" makers. And isn't Oxford Street the home of the electric masseurs and face-lifters?

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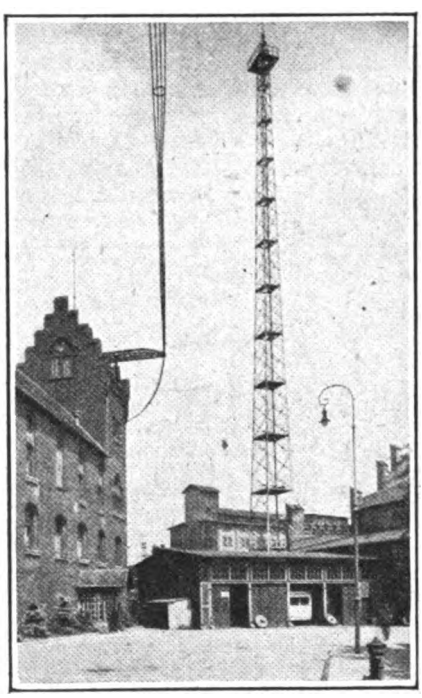
"Journey's End."

In obtaining permission to broadcast that epic war play, "Journey's End," on Armistice Day, the B.B.C. creates a precedent in that the play will be performed at the studio microphone while simultaneously running at a London theatre. The author, Mr. R. C. Sherriff, will himself make the slight alterations necessary for the broadcast version and will collaborate with Howard Rose in its production.

"Journey's End" will be broadcast from all stations except 5GB, but including the Empire short-wave station 5SW.



MÜNSTER. An unusual view of the German relay station with its imposing lead-in. Münster transmits on 234 metres.

oooo

Winter Symphony Concerts.

On October 12th the B.B.C. opens the 1929-30 season of Symphony Concerts in the Queen's Hall. Twenty-three concerts will be given, of which two (those on October 12th and November 1st) will be contributions to Sir Thomas Beecham's Delius Festival. Other conductors during the series will include Sir Henry Wood, Sir Landon Ronald, Hermann Scherchen, Franz von Hoesslin and Ernest Ansermet.

The National Chorus—a good test for the loud speaker!—will be heard in three choral concerts, and there will be many well-known soloists. All the concerts will be broadcast.

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Commonly Speaking.

From a correspondent of the B.B.C. in the Argentine:—

"Your transmissions are vulgarly received on 3 lamps."

oooo

Short Plays from 2LO.

Two short plays will be heard by listeners to 2LO on September 27th. The first, "Wind Up," is by J. Jefferson Farjeon. The second, entitled "The Split in the Cabinet," adapted from the story by Stephen Leacock, is by V. C. Clinton Baddeley.

oooo

Gael Warning.

The chief event of the Gaelic year in Scotland—the National Gaelic Mod—has come to be regarded as a regular source for broadcast relays. For the past three years extracts from one or other of the concerts of the Mod have been relayed. This year a portion of the prize-winners' concert on October 4th is to be relayed through Dundee from Perth for broadcast from all Scottish stations. In this programme listeners should have an opportunity of hearing some of the finest Gaelic musicians of the country.

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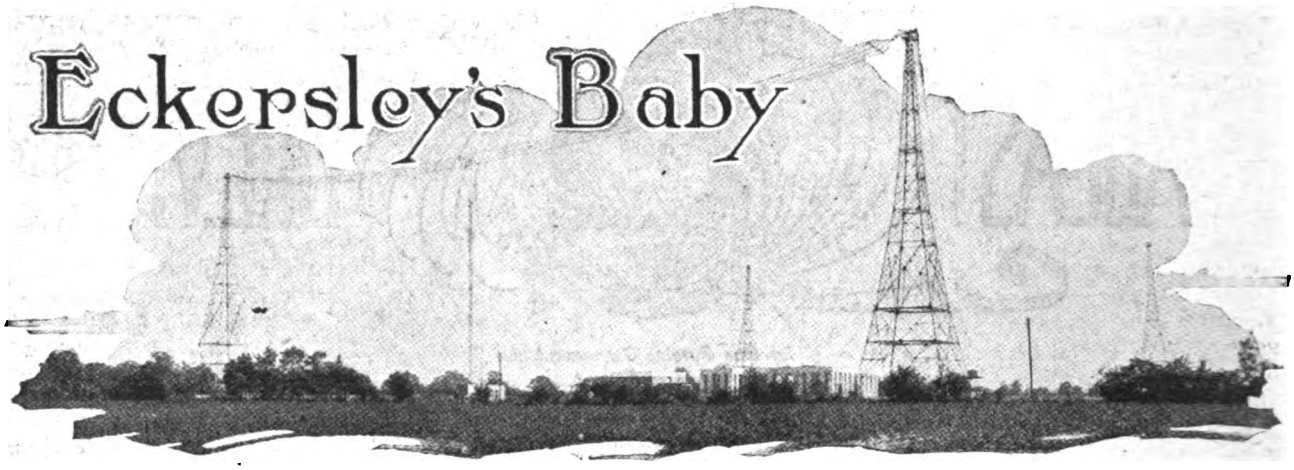
Eckersley's Baby



A Visit to "London Regional."

THE natal cry which shook the European ether and inaugurated the British regional scheme in the early hours of Monday last emanated from a station which, to judge from appearances, must mark a new standard of achievement in the annals of the B.B.C. To the eye of the visitor the Brookman's Park Twin Regional Station presents a spectacle of extraordinary symmetry, the almost severe buildings standing like a Druid circle in the centre of a small plateau and exactly midway between the two pairs of 200ft. lattice masts.

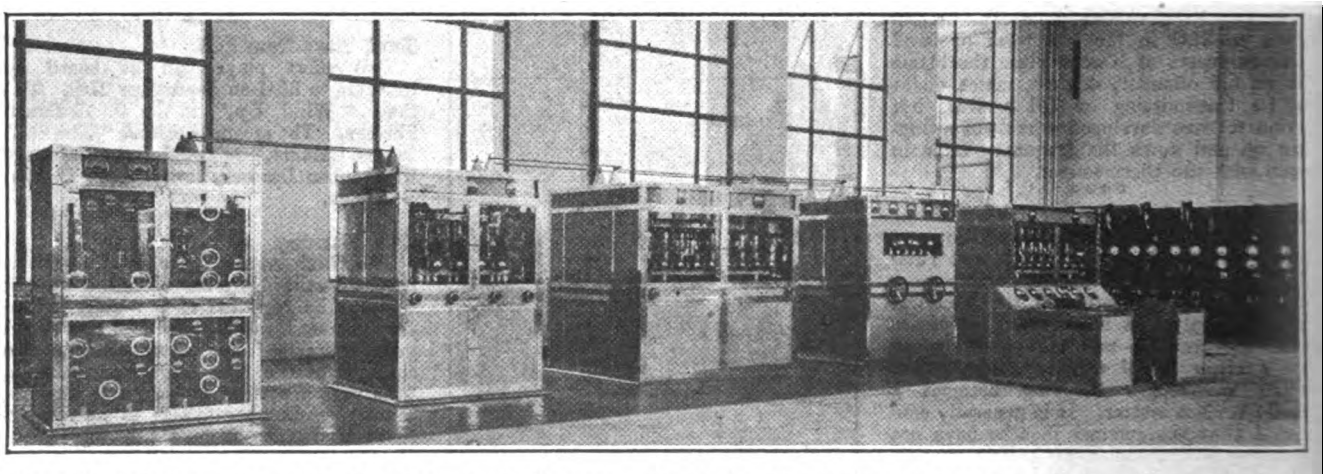
Entering the buildings at the east end, we find ourselves in the power house. Power is derived from Diesel generating plants. These machines, which run at 300 revolutions per minute, provide 300 h.p., giving an output of 2,700 amperes at 230 volts. It is interesting to note that precautions have been taken to prevent the transmission of vibration to the valve equipment by mounting each of the generating plants on a concrete bed which is independent of the foundations of the building.

The use of a D.C. supply may be criticised, but its adoption makes possible the use of a floating accumulator battery capable of providing power to one transmitter in the event of engine failure.

Passing from the generator and battery rooms we find all the necessary machines for generating anode and filament current not only for the main transmitting valves, but for the auxiliary, oscillating and modulating equipment.

Progress in Generator Design.

A type of generator which marks progress in the design of machines of this class is in use, and is the product of the English Electrical Company. The armature is entirely insulated from its spindle, is built in two sections, and fitted with four commutators. By this means a potential of 12,000 volts is obtainable from a single machine. There are three of these H.T. machines, each generating 160 kW. and direct coupled to orthodox D.C. motors driven from the motor generator sets already referred to.



One of the twin transmitters at Brookman's Park. On the extreme left are the drive oscillator and separator. Next is the modulating unit. This is followed by two banks of valves used for aerial excitation, and between them is the aerial tuning equipment, which connects through the feeders to the additional tuning inductances situated at the foot of the aerial and midway between the masts.

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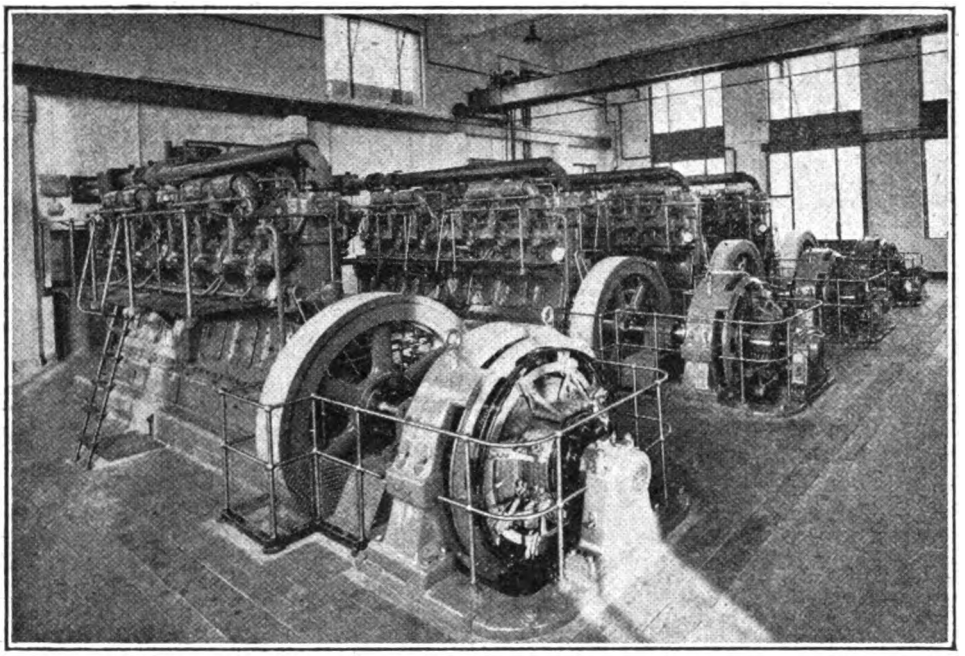
Eckersley's Baby.—

As readers already know, the station is doubly equipped for the purpose of transmitting two programmes simultaneously on two wavelengths. Two of the three motor generators will thus be used together, the third being a spare for emergency use. Accommodated alongside the H.T. machines are three L.T. generators each with an output of 1,300 amps. at voltages from 15 to 30. These machines, as well as those used for various anode voltages, grid biasing, etc., are in triplicate, so that in every case there is a stand-by generator.



General view of the power house. A sound insulating channel surrounds the foundations of the machines.

The main hall of the building is taken up with the transmitting equipment. Facing each other along the two sides are two identical transmitters each arranged to handle a separate programme through its own aerial system. The circuit adopted is similar to that employed at Daventry 5GB and consists of an oscillator (which can, if necessary, be fork controlled) which governs the lower power modulated oscillator through an intermediate tuned circuit called the separator. This arrangement prevents fluctuation of frequency within small limits.

The aerial is excited from two banks of eight water-cooled valves which are in opposite phase across the tuning inductance. A tuned feeder system couples the aerial with the transmitter, the necessary apparatus for tuning being housed in a small building immediately beneath the centre of the aerial.

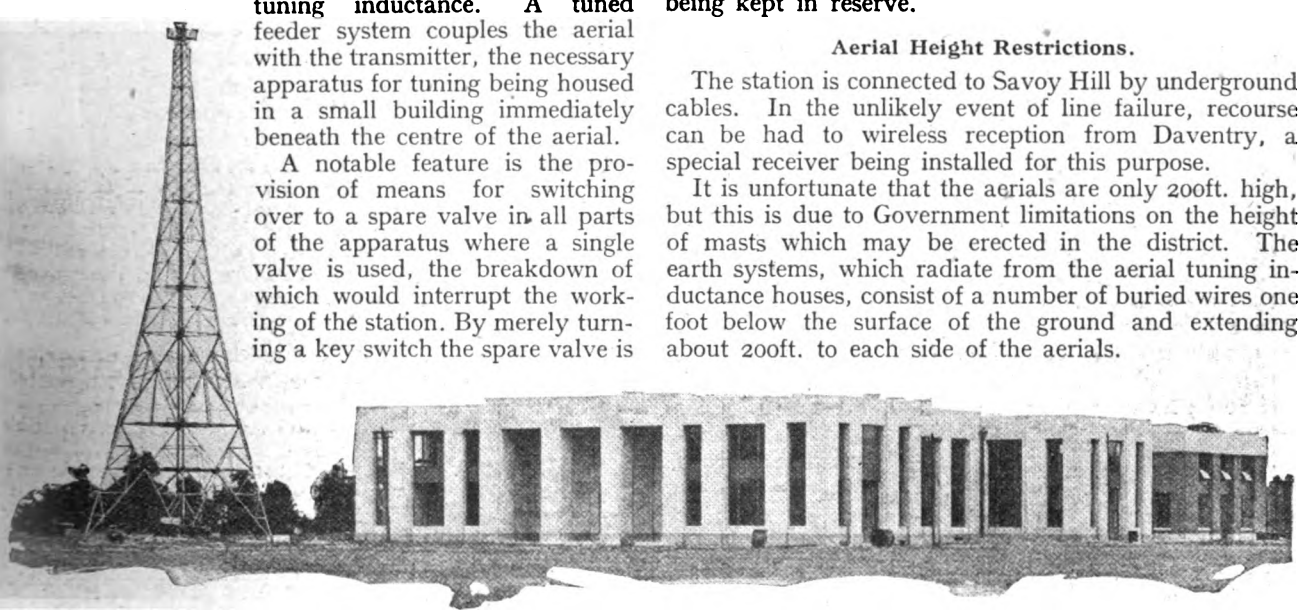
A notable feature is the provision of means for switching over to a spare valve in all parts of the apparatus where a single valve is used, the breakdown of which would interrupt the working of the station. By merely turning a key switch the spare valve is thrown into circuit. Precautions have also been taken in connection with the paralleling of the main oscillating valves to prevent circulating currents, and by an arrangement of chokes each valve functions independently of its partners.

As already explained, modulation is at low power, i.e., the modulation is supplied to the intermediate oscillator. Each transmitter normally delivers 30 kW. to its aerial. It is believed that almost full power is being used during the present tests, a small amount being kept in reserve.

Aerial Height Restrictions.

The station is connected to Savoy Hill by underground cables. In the unlikely event of line failure, recourse can be had to wireless reception from Daventry, a special receiver being installed for this purpose.

It is unfortunate that the aerials are only 200ft. high, but this is due to Government limitations on the height of masts which may be erected in the district. The earth systems, which radiate from the aerial tuning inductance houses, consist of a number of buried wires one foot below the surface of the ground and extending about 200ft. to each side of the aerials.



This view, taken from the south-west, shows the extreme simplicity in the design of the station buildings.

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The Design of A.C. Mains Sets

Details of a Typical Three-valve A.C. Set.

By W. T. COCKING.

(*Concluded from page 238 of the previous issue.*)

THE rectifier is the next question, and on this point the writer is at variance with most other people. Nowadays anode bend is always recommended for quality, and is particularly recommended for A.C. mains receivers. With regard to the latter, it is usually said that grid rectification is dangerous from the point of view of hum; for, as the grid is only earthed, as far as low-frequency currents are concerned, through a very high resistance, it is liable to pick up hum. Though this is true in theory, it has been found no more difficult to use grid than anode rectification; neither gives hum, nor is either more likely to pick up hum than the other. That, at least, has been the writer's experience.

Advantages of Grid Rectification.

With regard to quality the writer prefers a grid detector because he believes that under modern broadcasting conditions it gives better quality. Modern broadcasting is much more deeply modulated than that of a few years ago, and anode bend is increasingly inefficient as the percentage modulation grows, while the grid rectifier does not appear to be so badly affected. In the writer's opinion, the only real fault of the grid detector is the load it places on its grid circuit, but if only a small positive potential, or, in the case of some A.C. valves in which grid current flows even when the grid is negative, no grid potential, is applied, this damping is greatly reduced. If little or no bias is used, the quality is distinctly improved by using a small grid condenser, about 0.0001 mfd.

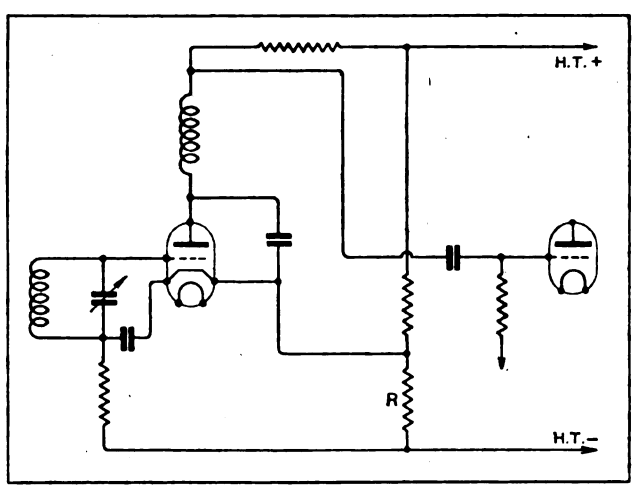

Fig. 3.—With an indirectly heated anode bend detector valve "free" grid bias can be obtained from an anode feed potentiometer, one arm of which is shown as R.

If anode bend rectification is used, the negative bias cannot be obtained from the voltage drop across a resistance in the H.T. return lead; for with an anode rectifier the anode current is dependent upon the strength of the incoming signal. It can, however, be obtained from the anode feed potentiometer, as shown in Fig. 3; the formula for calculating the resistance of R is the same as for an L.F. stage, except that the value used for the current will not be the anode current of the rectifier, but the current flowing through the resistance which forms the arm of the potentiometer nearest the H.T. return lead.

Finally, care should be taken in the disposition of the components, although this is not critical if the power unit is built in a separate box from the set and placed at some distance from it. If, however, the whole apparatus is built into one cabinet, care will be necessary; in fact, at first it is unwise to screw down any of the transformers, as it will probably be necessary to rotate them to find the position of minimum hum. A carefully built set will work as well as one built in two sections, but the transformer positions are critical, even if they are quite a distance apart.

Suggestions for a Three-valve A.C. Set.

In Fig. 4 is shown the circuit diagram of the writer's receiver and power unit, which has been in use for several months, and which has proved so satisfactory that he would now never go back to batteries. It was designed in accordance with the principles outlined in this article; there is no H.F. stage, as it was intended for use on London and 5GB only, but a stage could easily be added, as in Fig. 5, where the biasing arrangements should be carefully noted. The current flowing through the resistance R, which provides the bias, is not only the anode current of the screened valve, but also the screen current and the anode current of the detector. That is, the total current through R is the anode current of the first valve, plus the screen current, plus the anode current of the detector, and this value must be used when calculating the required resistance of R. In practice it would probably be best to use a variable wire-wound resistance, when the actual value of the grid bias could be adjusted while the set was working.

Filament Hum.

The indirectly heated screened valves have remarkable characteristics, and will give a greater H.F. stage gain than any other valves; an attempt, however, to heat the filament of an ordinary battery type screen-

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The Design of A.C. Mains Sets.—

grid valve with A.C. was a failure owing to hum. The reason for this hum is rather interesting, for it is obtained even when the H.F. couplings will not pass low-frequency currents, but it is only obtained when the set is tuned in to a station. At first sight it appears impossible for there to be hum with such a circuit, but in reality the A.C. current heating the filament causes the anode current to vary at the same frequency, and modulates the carrier of the incoming signal with a 50-cycle note; this, of course, is rectified and amplified by the low-frequency stages. This suggests a remedy; if the low-frequency stages will not amplify a 50-cycle note, an ordinary valve can be used for the high-frequency stage, but it is a poor way out, for the bass notes in the transmission will be cut off also. It is only useful in cheap sets or where much bass is not wanted.

While it is true that the results with a mains set are better than those with one operated from batteries, the improvement is not necessarily in the form of increased amplification. The higher mutual conductance (usually double) of valves of the indirectly heated cathode type enables much greater amplification to be obtained, but it also enables better quality to be obtained without loss of amplification as compared with a battery set. For example, with a transformer-coupled L.F. amplifier, using a battery type valve of 20,000 ohms A.C. resistance, the stage amplification will usually be about 60, but if a mains valve of the same resistance is substituted the amplification will be doubled. On the other hand, if a mains valve of about 10,000 ohms be used, the amplification will be the same as with a 20,000-ohm battery valve, but the quality will be much better. The reproduction of both bass and treble will be improved by the use of a lower resistance valve, and, in addition, it will reduce the risk of distortion due to overloading.

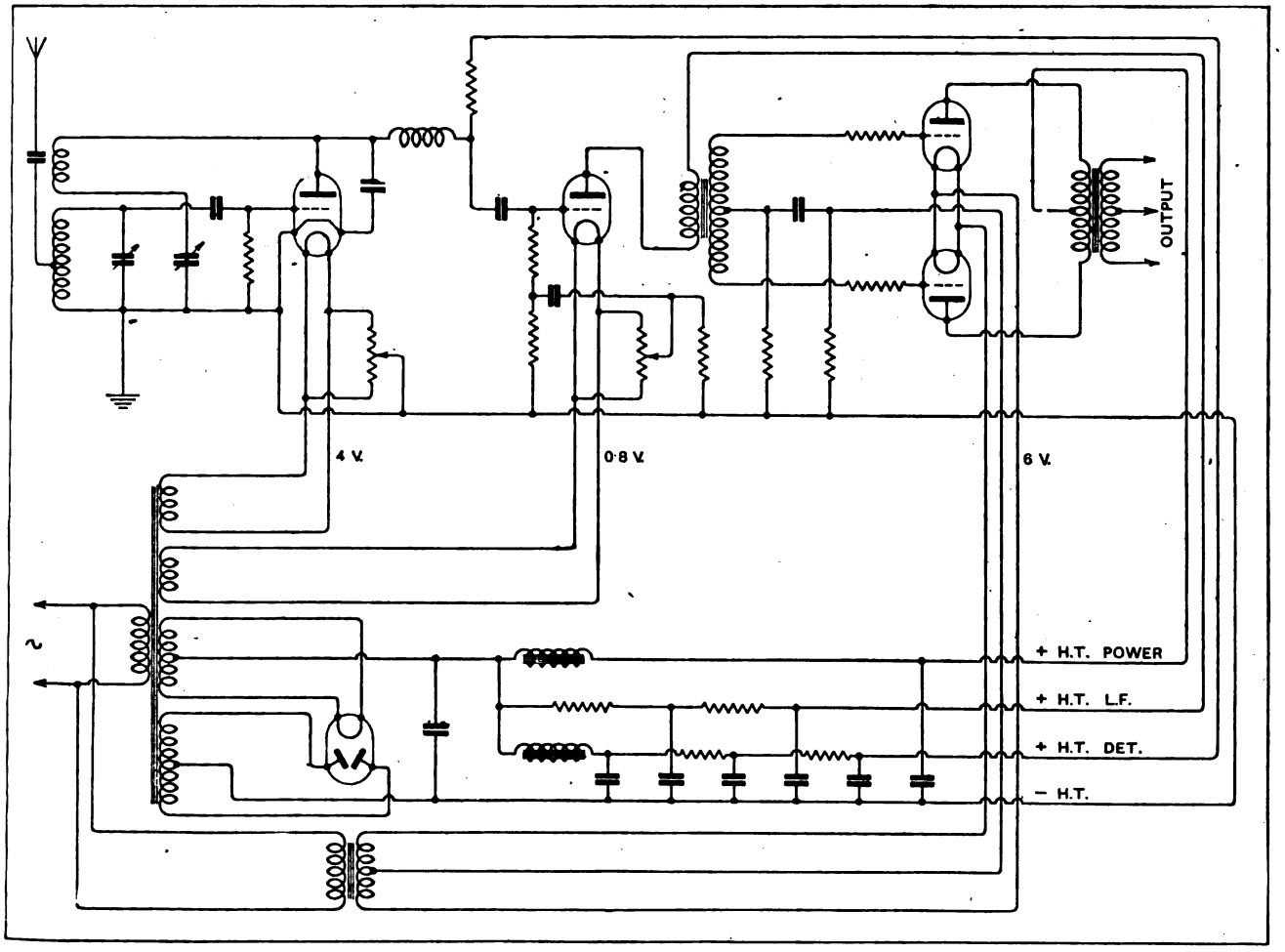

Fig. 4.—Circuit details of a complete three-valve receiver entirely operated from A.C. mains. An H.F. stage is not used as the receiver was primarily intended for the reception of 2LO and 5GB.

In the H.F. amplifier, too, it is not always advisable to try to obtain the very utmost in the way of amplification. It is sometimes very tempting to try to obtain an amplification of 300 or so from an indirectly heated screened grid valve, but when the questions of selectivity and quality are considered, it may be found that it is better to sacrifice some of this high amplification. With any set the higher the amplification the greater

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The Design of A.C. Mains Sets.—

will be the selectivity required; the usual circuits for high amplification are no more selective than a neutralised amplifier where the stage gain is only about 40. It is not generally realised that the high-note loss in an amplifier using very low loss coils may reach the alarming figure of 90 per cent.! By means of a special circuit, using an A.C. mains valve, it is possible to reduce this loss to only 10 per cent., and still obtain, with no reduction in the selectivity, a stage amplification of 60, which is as high as that obtained with an ordinary battery screened grid valve.

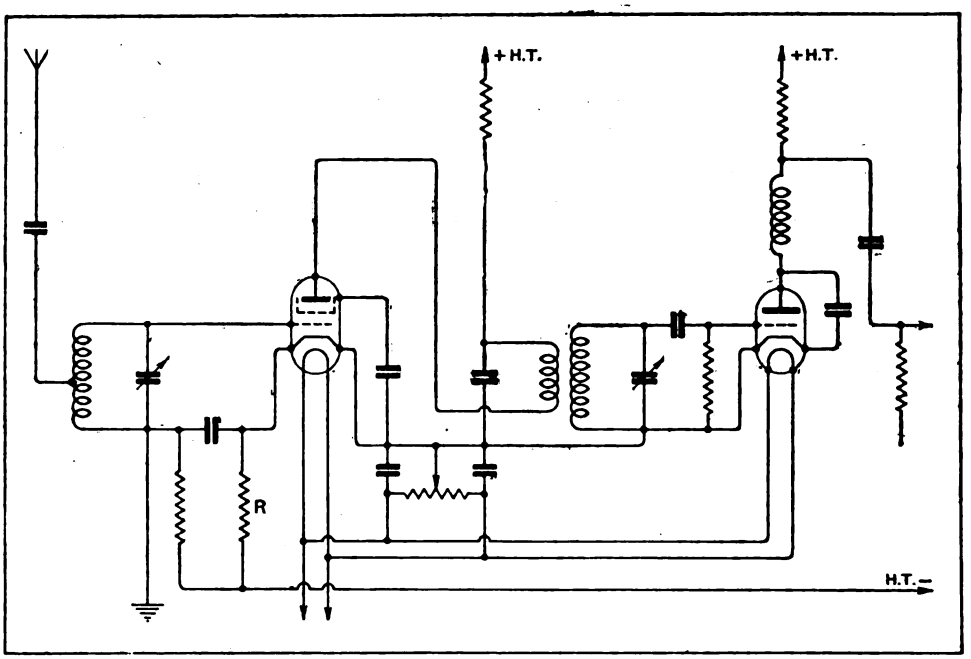

Fig. 5.—Suggested connections for an H.F. amplifier in which grid, anode, filament and screen obtain their working potentials from A.C. mains.

In view of this it is the writer's opinion that the greatest satisfaction will be obtained from a mains set if the questions of quality and selectivity are made the prime considerations, while mains hum need not be feared if the above precautions are carried out.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS?

Sir,—May I be permitted to say a few words about this "Amateur Status" business?

Mr. T. P. Allen in his letter says that he had not previously heard of the A.B.R.S.!

How many amateurs could say that they had never heard of the R.S.G.B.? I venture to say—not one. Surely this in itself proves that the R.S.G.B. is the official amateur society of this country.

In reading through many foreign amateur radio journals one invariably sees the R.S.G.B. mentioned, but I, personally, have never seen any mention of the A.B.R.S.! Why?

Remarks have also been made about the R.S.G.B. being a "London Society." All I can say about this is: one only has to go to the annual convention of the R.S.G.B. to prove this statement to be utterly ridiculous.

I live forty miles from London, but I can say that the R.S.G.B. have always helped me in every possible way, and have always replied to my letters *by return of post!*

Further, its membership is increasing daily, and I am certain that amateurs would not join if they felt a better society existed. I, with many others, consider it an honour to be a member of the R S G.B.!

Before closing I should like to say a few words about "This QSL Business."

Mr. Ashton J. Cooper and others regard the exchanging and collecting of QSL cards as "a foolish idea."

I very heartily disagree!

I certainly have no patience with "the wall-paper type of collector," but I have always considered that when one works a station it is part of his duty as an operator of a private station to confirm every 'contact made."

If it were not for QSLs, what should we have to prove that we have worked certain stations or countries?

They alone form a very helpful log, and also form a bond of friendship between the two stations.

I send a QSL to every station worked, British or Continental, and, further, if another fellow takes the trouble to send me a report on my signals, he gets my card and thanks, always, in return.

I do not operate my station just to collect cards—far from it—but I feel that after working a station it is up to me to see that he gets a further report and confirmation of our QSO.

I would add that only 75 per cent. of the stations who receive my cards send me theirs. I am pleased to say, however, that nearly every G station QSLs, sometimes *via* R.S.G.B.!

Has the A.B.R.S. a QSL service? I have never heard of it.

In closing, may I, through the columns of your valued journal, wish the R.S.G.B. further success, and thank you for publishing such interesting articles and letters?

JAMES N. ROE.

Sir,—There are to-day a large number of amateurs engaged in carrying out experiments of an important nature, and they do this by getting in touch with another amateur who reports on their signals. Thus every new amateur means another station to help with these experiments.

Those who hear their "bleatings and croaks" think that they are talking utter rot, whereas they are probably experimenting with duplex telephony or crystal control.

People who don't know all this ought not to criticise amateurs. Do not suppress them, but rather give them every assistance possible, and they will amply repay, by the result of their experiments, any assistance given to them. B.R.S.260.

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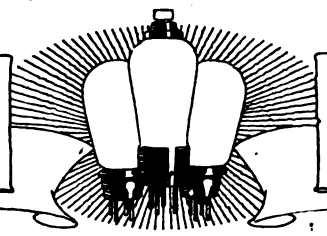
READERS' PROBLEMS.



"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

A Source of Lost Energy.

From several recent articles I gather that it is good practice to determine experimentally the number of primary turns of H.F. transfotmers used with S.G. valves. It is therefore proposed to adopt a sectional form of winding with more sections of fewer turns than those used in "The Wireless World" designs—and to short-circuit any sections that are found, on trial, to be superfluous. I take it that this will be better than a tapped primary, with its dead-end effects? J. T. S.

We would strongly dissuade you from adopting your proposed scheme. The practice of short-circuiting sections of coils wound in the manner described is seldom permissible nowadays, and then only in cases where the various sections are adequately spaced, with this object in view. It is an axiom in H.F. transformer design that all the primary turns shall be tightly coupled to the secondary, and if a section is short-circuited a considerable amount of energy will be absorbed from the latter coil.

We agree that it is highly desirable to adjust the primary winding so as to suit the characteristics of the S. G. valve in use, and also the particular needs of the user. Adjustment is best made by removing superfluous turns, but, if you prefer it, there is little reason why a tapped winding should not be used, particularly if the number of "dead" turns is small.

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How It Works.

Will you please give me a few words of explanation as to the working of the "free" grid bias scheme included in the "Foreign Listeners' Four"? I am thinking of making up a set on similar lines (but with a single H.F. stage), and should like to understand this part of the circuit fully before beginning operations. T. F. A.

This free grid bias scheme is not difficult to understand. If you study the circuit diagram of the receiver in question, it will be apparent that the cathode lead of each valve requiring a negative bias is joined to the common H.T. negative bus bar through a small resistance; the anode current of the valve must consequently flow through this resistance, producing a voltage drop which is applied to the grid circuit.

The matter will perhaps be made more clear by referring to Fig. 1, which shows the essentials of a single-valve circuit, without extraneous complications It should be observed that the grid return lead must be joined to the negative H.T.

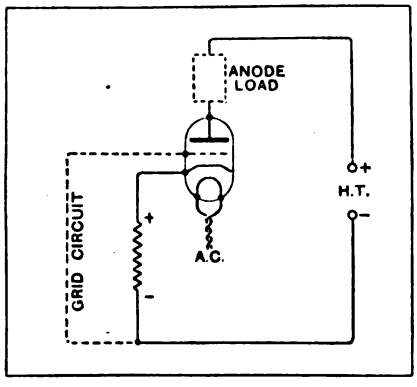

Fig. 1.—Simplified diagram showing principle of "free" grid bias.

lead in order to take advantage of the difference of potential across the resistance, which, incidentally, is always shunted by a large condenser providing a low-reactance return path for H.F. or L.F., as the case may be.

Not the least of the advantages of this method lies in the fact that it is more or less self adjusting to variations in anode voltage; if this voltage (and consequently current) is increased, the voltage difference existing across the ends of the bias resistance will automatically rise, providing more grid negative.

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Look to Grid Bias.

I have just noticed that signals increase in strength very noticeably when the H.T. plug feeding the detector valve of my "Everyman Four" is removed from the battery. This increase, however, is only momentary, as signals soon die away altogether unless the plug is replaced.

The general performance of the set is not as good as formerly; is the above symptom of any help to you in forming an opinion as to what may be wrong? L. G. B.

It seems probable that the negative bias applied to the detector valve is somewhat less than it should be, and that better rectification is taking place when the applied anode voltage has dropped considerably (through discharge of the by-pass condenser).

It is quite possible that the anode resistance has changed in value; this is more likely to be the case if you are using a grid leak type of resistor in this part of the circuit.

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An American Set.

My five-valve set, of American manufacture, has "power" valves in the two H.F. stages. Do you consider that it would be worth while replacing these with modern "H.F." valves? My object is to increase range: selectivity is already quite adequate for this district. S. R. F.

The majority of American "2-H.F." sets of a few years ago included neutralised transformers designed for valves of some 8,000 ohms impedance. The primary windings were small, and we consider that results would be disappointing were you to make the proposed change.

It is just possible that H.F. magnification could be appreciably increased—perhaps doubled—by using modern high-efficiency valves of the type sold for anode bend detection ("D" or "D.E.L." type). The impedance of these valves is about right, but we hesitate to recommend them to you definitely, for the reason that the balancing and screening arrangements of the set may well be inadequate to cope with the increased amplification available. More sensitivity is useless unless it is accompanied by stability.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Modified Hum-proof Eliminator.

I should like to make up the Hum-proof D.C. Eliminator, as described in "The Wireless World" for August 28th, for use with my Kilo-Mag. Four, but as I do not wish to apply more than the specified maximum voltage of 150 to my output valve, have come to the conclusion that it should be possible, in the interests of economy, to dispense with some of the output feeds, and to supply all the anodes with the voltage mentioned, on providing a potentiometer as described for the two screening grids.

If you approve of this, will you please let me have a circuit diagram of the eliminator, modified to suit my requirements? F. N.

As you suggest, the set will work well with a common anode voltage of about 150, and, unless you wish to apply a pressure in excess of this to the output valve, it is possible to effect an economy by simplifying the eliminator, particularly as in this case there is no need to use the various parallel feed circuits for decoupling.

The modified circuit diagram is given in Fig. 2; R_1 is a voltage-absorbing resistance, of which the value will depend on the current taken by your valves and on mains voltage, and must be determined by calculation; 4,000 or 5,000 ohms is likely to be about right. R_2 and R_3 are the two elements of the screening grid potentiometer, and may have the value allotted to them in the original article.

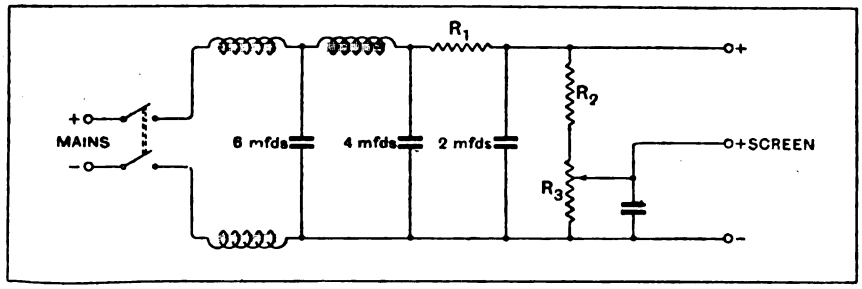

Fig. 2.—Simplified circuit of Hum-proof D.C. Eliminator giving a single H.T. voltage with a supplementary screen-grid supply.

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Switching Neutralised H.F. Amplifiers.

I notice that waveband switching is but seldom included in circuits with neutralised three-electrode H.F. valves, although it is almost universal in "S.G." sets. Is there any basic reason why this switching should not be as successful in the former class of receiver? N. H. M.

Switching of the circuits associated with a three-electrode H.F. amplifier can be carried out quite successfully, and need not introduce much loss—certainly not more than 10 per cent. in voltage amplification—but, due to the need for changing over the neutralising arrangements, connections are much more complicated. This is particularly true when attempts are made to attain high efficiency on both medium and long wavebands.

Spacing Between Coils.

The practice of winding medium- and long-wave transformers on the same former, exemplified in several recent "Wireless World" designs, appeals to me, but no design on these lines has yet been published that satisfies my own requirements; this is probably because I intend to use, for my new set, a screening box rather smaller than usual, and am consequently forced to reduce the dimensions of my coils.

The point on which I specially need information is concerning the minimum spacing between the two sets of windings. The majority of published designs show a clear 1½in. or more. Is it permissible to reduce this appreciably? H. M. W.

Generally speaking, the medium- and long-wave coils should have a clear spacing of between 1in. and 1½in. The greater dimension is applicable to the more ambitious type of coupling.

From the fact that you propose to use a smaller screening box than usual, it is inferred that no attempt is being made to obtain the maximum possible H.F. stage gain, and so we consider that an inch spacing will be ample, especially as your transformers are to have a smaller diameter than usual.

A Continuous Waverange

Almost without exception, sets designed for broadcast reception cover the wavelengths between, roughly, 250 and 600 metres and 900 and 2,000 metres. It happens that I particularly wish to receive transmissions on about 800 metres; can you refer me to a published design that does not "miss" this intermediate wavelength? T. D. S.

As a matter of fact, it is by no means difficult to design a receiver to cover the entire waveband without a gap from about 250 to 2,000 metres in two steps; indeed, more than one set described in this journal will do so, and the majority will tune to 800 metres on the long-wave setting. Unfortunately, this wavelength is received with the tuning condensers near their minimum capacity, and consequently selectivity is poor.

It may be added that, almost without exception, those sets with 0.0003 mfd. tuning condensers described in this journal may be made to cover the complete band specified by substituting 0.0005 mfd. If you adopt this plan, however, it would be well slightly to reduce the inductance of the long-wave coils.

We suggest that you should write to us again, giving full particulars of the type of set required.

o o o o

Threshold Howling.

My short-wave set is fairly satisfactory, but suffers from one disability about which I am seeking your advice. On increasing reaction gradually, a point is reached where violent L.F. oscillation is produced; this seems to occur just before the detector valve goes into H.F. oscillation.

Apart from the fact that, apparently, it is impossible to increase sensitivity (by reaction) to the fullest possible extent, the effect is extremely annoying when wearing headphones. Can you suggest a cure? A. A. D.

This effect, known as threshold howling, is well known, and is, indeed, one of the bugbears of short-wave reception. In the first place, you should observe the fullest possible precautions against passing H.F. energy into the L.F. amplifier. Attention to this matter will often effect a cure, but if it does not, we suggest that you should increase the value of the detector grid leak—even up to 10 megohms—and also fit a detector potentiometer, so that the positive voltage applied to the grid may be reduced to the smallest value consistent with good rectification.

o o o o

Visual Indication of Wavelength.

I have been considering the making of a modulated valve wavemeter, but it occurs to me that this complication is unnecessary now that I have fitted a low-reading milliammeter in the anode circuit of the bottom bend detector included in my set. Is it not a fact that the radiation of a simple heterodyne wavemeter, when picked up by the receiver, will produce a deflection of the meter, resonance being indicated by maximum current reading? L. H. A.

Your statement is quite correct, and, indeed, it is possible to get a more accurate reading by visual than by aural means. For your purpose, a simple oscillator valve, with a calibrated tuning scale, will be perfectly adequate.

ARE YOU A GOOD JUDGE OF WIRELESS APPARATUS?

Vote for your choice of the outstanding exhibit at the Olympia Show and qualify for the £50 cash prize offered by ***The Wireless World.***

SEE PAGE 268.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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WHY NOT COMPETITIVE PROGRAMMES?

THE Regional Scheme is under way and its introduction marks the first definite stage towards the provision of alternative programmes throughout the country. The public has never been really satisfied that the programmes hitherto have been all that they might have been, and the Regional Scheme of alternative transmissions is likely to receive a warm welcome because of the choice which it will provide. But it still seems doubtful whether a real contrast in the programmes can be provided so long as both programmes are compiled by the same organisation.

The B.B.C., through their stations, have a monopoly for the transmission of broadcast programmes, and we have always contended that it is right and proper that there should not be a division of control of the stations conducting broadcasting in this country amongst separate broadcasting organisations, as exists, for instance, in America. The technical difficulties in the way of distribution of programmes would be enormously increased if the arrangements ceased to remain in the hands of one authority. But when we come to look into the question of the compilation of the programmes themselves, it would seem to us that the desirability of a single organisation no longer exists. With two programmes throughout the country, what objections are there to two separate and distinct organisations to conduct the alternative programmes?

Two Separate Programme Boards.

If we could arrange for two separate programme organisations within the B.B.C. to be set up we should arrive at a stage where there was definite competition between the two organisations to vie with one another in a competitive spirit. But it would seem that it would be possible to extend this idea still further. By now the sum of money available for expenditure on programmes can be approximately estimated in advance, and this sum, divided into two equal parts, is the amount available for expenditure on the alternative programmes. If the Government were to invite, through the B.B.C., tenders for the supply of programme matter, is it not conceivable that offers would be forthcoming which would insure for the public a better choice than is likely to be available so long as the compilation of both programmes remains under the same control? The B.B.C. would, of course, be entitled to retain their special features of educational broadcast, and so forth, and would exercise, as they do at present, a censorship over all the matter to be broadcast.

Any such drastic change in the general arrangements could not, of course, be put into force until the conclusion of the present guaranteed term of office of the B.B.C., but there would seem to be no obstacle to the immediate separation of the compilation of the alternative programmes by constituting two independent and competitive programme organising staffs within the present B.B.C. organisation, and it would probably not be long before a healthy rivalry between the two departments would do much to insure for the public a very much better choice than the programmes could otherwise be expected to provide.

It may be argued that such an arrangement would mean an expensive duplication of staff at the B.B.C. which would not be justified by results, but as we visualise the scheme the duplication would only occur in the constitution of the Programme Boards; all the machinery of programme preparation could remain as one organisation as at present, and time would be allotted for those special types of transmissions now specially arranged by the B.B.C., and they would be common to both the alternative programmes.

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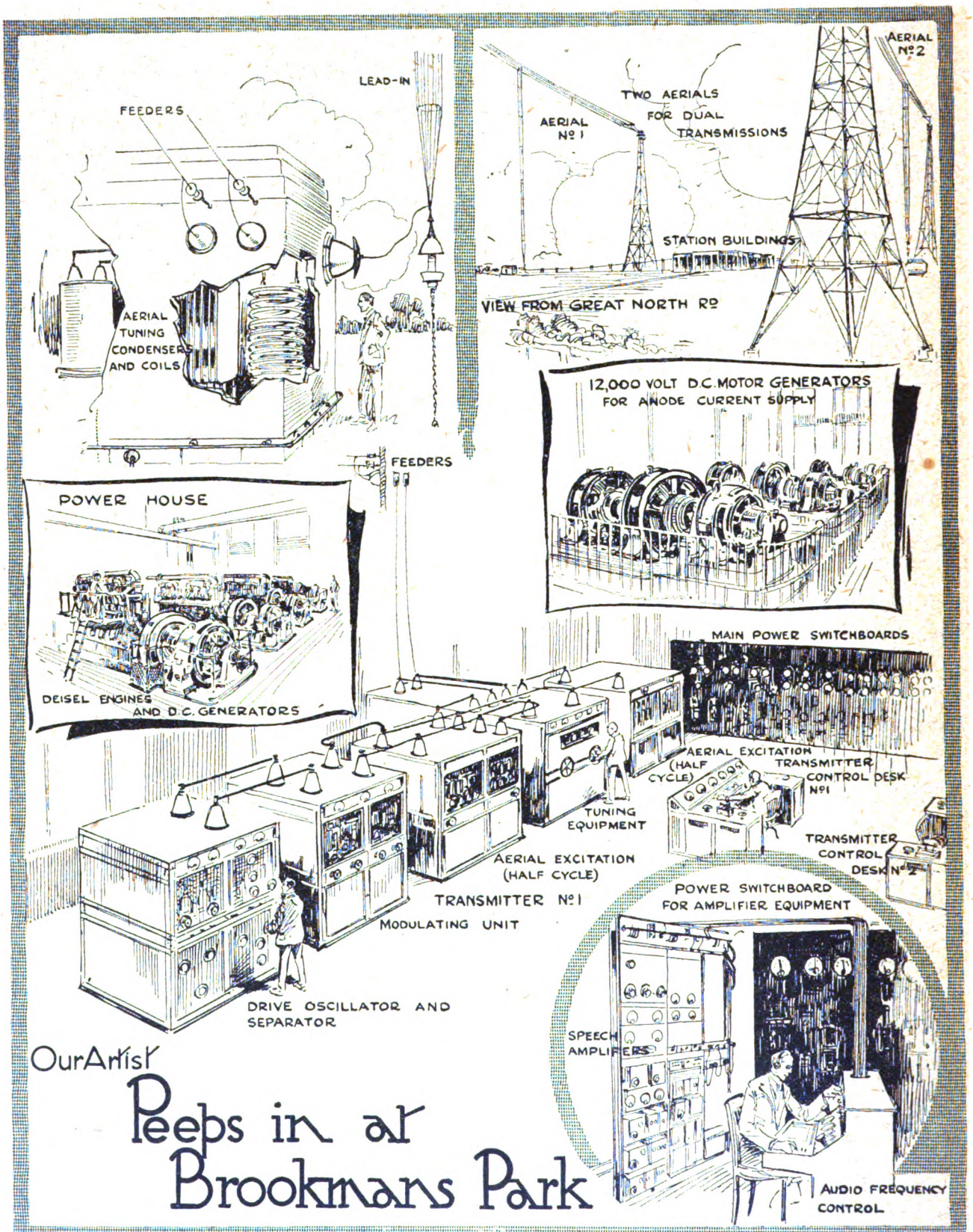

Our Artist

Peeps in at Brookmans Park

B. 12

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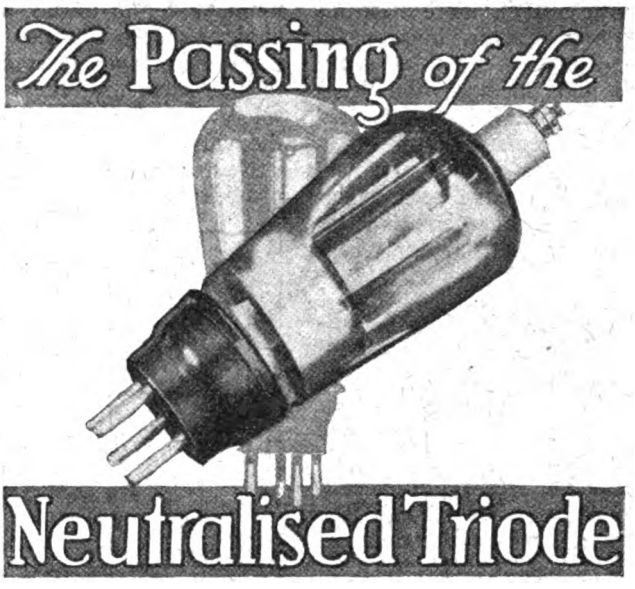

The Principles of the Screen-grid Valve Simply Explained.

By A. L. M. SOWERBY, M.Sc.

OF all the problems that arise in connection with the reception of wireless signals, there is none that is more fascinating, or that has been attacked in a greater diversity of ways, than that of the satisfactory amplification of the original high-frequency currents derived from the aerial. Its fascination arises partly from the fact that the use of effective high-frequency amplification affords the only really satisfactory means of receiving signals from a distance, and partly from the very considerable difficulties that the evolution of a really satisfactory high-frequency amplifier has presented.

In the early days of broadcasting, the coupling between the valve amplifying at high frequency and the detector was usually a simple tuned coil, employed in the tuned anode circuit of Fig. 1. So long as coils of high resistance were used, and the aerial was connected directly to the grid of the valve to provide additional damping, this arrangement gave quite appreciable amplification, so that signal strength was much better than could be obtained by connecting the detector directly to the aerial. It was soon found, however, that by employing a better coil, combined with a more satisfactory mode of coupling the aerial to it, a receiver without the high-frequency stage, but having reaction to take its place, gave equally good signals from distant stations.

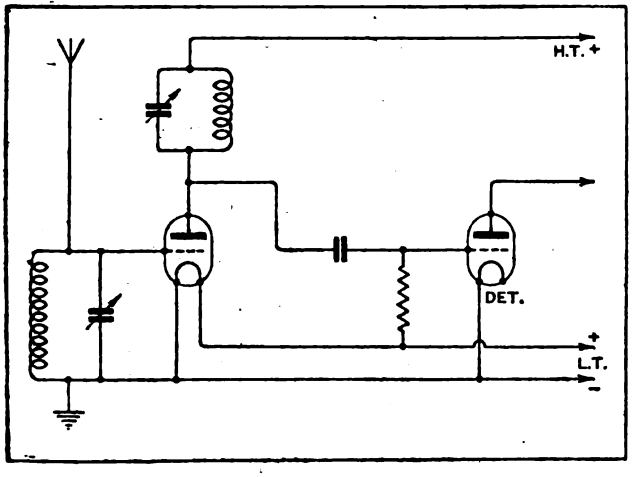

Fig. 1.—The old tuned-anode circuit. The arrangement is inherently unstable for the reasons given in the text, but with high-resistance coils and heavy aerial damping, it can be used.

The obvious step was next to build up again the high-frequency amplifier, using the better coils and with a lighter coupling to the aerial, in the hope of combining the advantages found to follow upon these improvements with the amplification of the extra valve. It was then found that the elimination of the coil losses and, still more, the partial removal of the aerial damping, which had hitherto been like a millstone round the neck of the receiver, had the result of causing the set to oscillate violently and uncontrollably as soon as the two circuits were brought into tune with one another, so that the reception of distant stations, instead of being facilitated, was rendered utterly impossible.

This extremely unsatisfactory state of affairs was chiefly due to a cause which has been the main stumbling-block in the way of producing efficient high-frequency amplifiers at all stages of their development. If we consider the valve of Fig. 2, and remember that the grid is being made alternately more positive and more negative than the filament by the application of the high-frequency voltage derived from the aerial, we can follow out quite simply the process by which the unwanted oscillation is set up. At any moment when the grid is made positive by the received signals, it attracts a larger number of electrons than usual through its meshes, and passes them on to the plate, which is thereby made momentarily more negative. Since plate and grid, together with the leads running up to them through the valve, are in quite close proximity to one another, this momentary excess of electrons on the plate reacts upon the grid, repelling electrons out from it and so making it even more positive than could be accounted for by the signals alone.

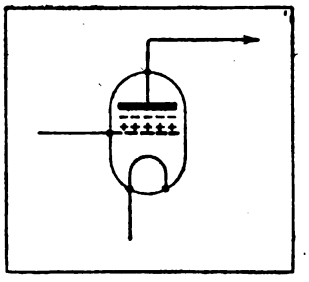

Fig. 2.—Showing how retroaction through the valve takes place in the circuit of Fig. 1. When the plate is instantaneously made more negative by the signals, it induces a positive charge on the grid which tends to set up oscillation.

When the signal voltage reverses, as it does every millionth of a second or less, and makes the grid negative, the flow of electrons from filament to plate is momentarily checked, so that the plate becomes temporarily more positive. The same thing happens again;

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The Passing of the Neutralised Triode.—

the positive charge on the plate attracts more electrons into the grid from the external circuit, once again enhancing the effect of the signals. Thus at every moment the proximity of the plate increases the signal voltage on the grid, with the result that, if not checked in some way, the signal voltage rapidly builds up to the largest value that the limitations of the valve will permit, no matter how small it might have been originally. This is the condition known to everyone as oscillation, which precludes entirely the satisfactory reception of speech and music.

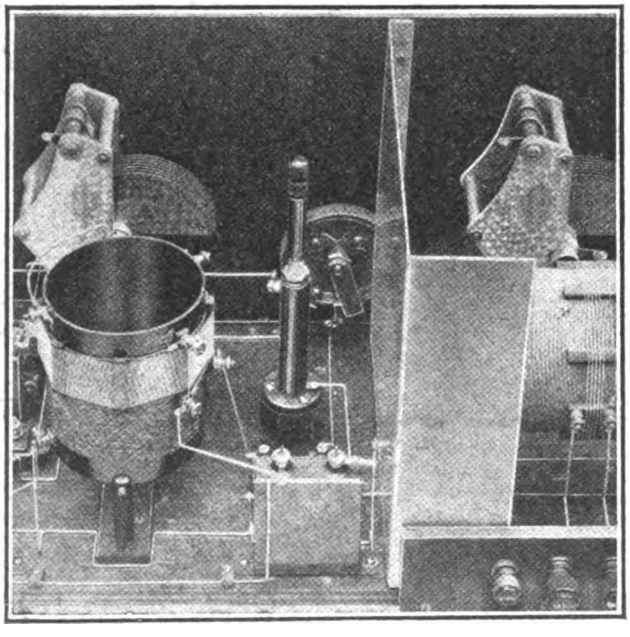
Systems of Neutralisation.

There are two known ways of avoiding this effect. The first, and the one which has held sway until very recently, is to provide artificially another pair of neighbouring conductors, equal in effective size to the grid and plate of the valve and their leads, and to connect one of them to the grid. The other is supplied with a voltage which is always positive when that on the plate is negative, and *vice versa*, so that electrons are attracted to the grid through this auxiliary circuit to the same extent as they are repelled by the plate. The two effects thus cancel, and the voltage on the plate has, on the whole, no reflex action on the grid.

This scheme is known as neutralisation, and the two conductors forming the "dummy valve" are made up in the familiar form of the neutralising condenser, which is made adjustable in capacity so that it can be made to match any valve. The reverse voltage required may be produced by any one of half a dozen different circuits, of which two samples are shown in Fig. 3. These, although they look different, are practically equivalent, for both depend on the fact that if a coil is earthed at its centre and supplied with high-frequency currents, the two opposite ends will at any moment be at equal and opposite potentials. The choice between a transformer and a circuit of the tuned anode type is a matter depending on the characteristics of the valve and the tuned circuit, and is concerned solely with the most efficient transfer of energy from the valve to the tuned coil.

Neutralised circuits built up on these or similar lines provide the only practicable method of obtaining good amplification from an ordinary valve, and so have very deservedly held the field for some years. With carefully chosen coils, an amplification of about sixty-five times in one stage can be attained, though to reach this figure involves a good deal of skill and knowledge on the part of the designer of the set, together with care and a conscientious obedience to instructions on the part of the constructor. A much less efficient stage, amplifying only some twenty times at most, has been widely regarded as highly satisfactory.

In extenuation of this modest aspiration, it must be remembered that the valve is only one of many paths by which amplified energy in the plate circuit can be fed back into the grid circuit to cause oscillation, and neutralisation can therefore only be fully effective if all these other paths are also closed. The chief of



A section of a well-known receiver in which the retro-action from plate to grid is balanced out on the lines of Fig. 3, by an auxiliary winding and a small condenser.

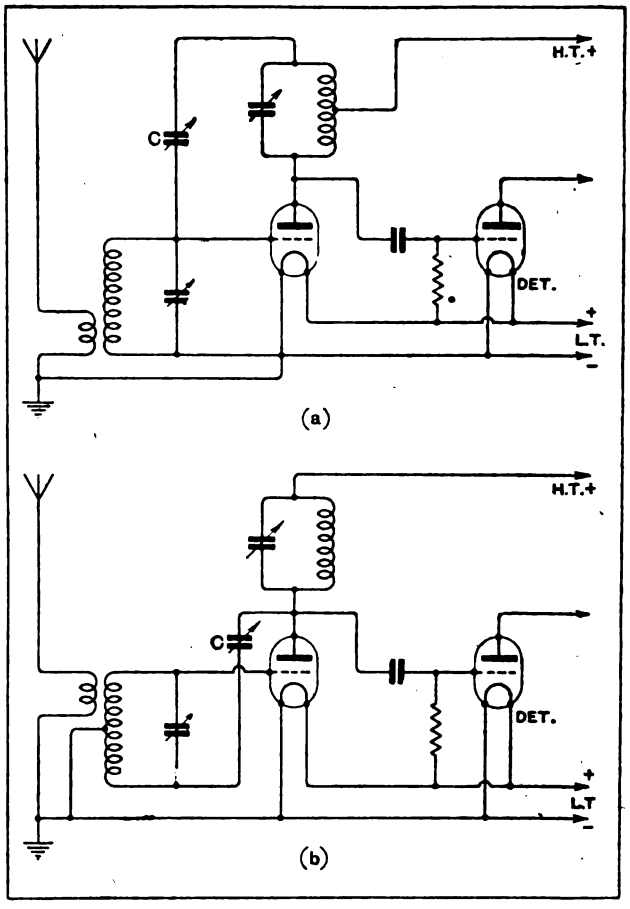


Fig. 3.—Neutralised circuits. Two modifications of Fig. 1 in which the reflex action of plate upon grid is balanced out. In (a) the voltage is reversed before being fed through C, and in (b) after passing through C.

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The Passing of the Neutralised Triode.—

these is due to the coils and the wires connected to them, which can transmit energy to one another in a way not so very different from that by which signals from a transmitter are picked up by a frame aerial. The only real cure for this lies in enclosing one or both tuned circuits, together with all leads which carry high-frequency currents, in a closed metal screening box, so that they cannot indulge in unauthorised transmission and reception. The expense of this proceeding has led to the design of many receivers in which amplification is kept down to so low a figure that this complete screening is not essential to stability.

It has been stated that there are two ways of avoiding the reaction of plate upon grid that causes oscillation, but so far we have only described one method, in which the fundamental effect is left untouched, while its results are balanced out. In Fig. 4 there is shown a repetition of Fig. 2, with the addition of an extra electrode between grid and plate. If this extra electrode is left connected to nothing, the plate, at a moment when the signals have made it more positive than usual, will attract electrons to the upper side as shown in the figure at (*a*). Since these electrons must come from somewhere, and there is no possible source but the extra electrode itself, this results in its under side becoming positive. The grid is then made more negative in exactly the same way as in the simpler case of Fig. 2, and with exactly the same unpleasant results.

But if the extra electrode is earthed, as at (*b*), we find a very different state of affairs. Once again the plate, momentarily made more positive by the signals, attracts electrons to the upper side of the extra electrode, but the electrons no longer have to come from its lower side, for the whole earth is now available as a possible source. No positive charge, therefore, appears on that side of the extra electrode which is next to the grid, and the latter is therefore completely unaffected by any momentary charge that the plate may acquire.

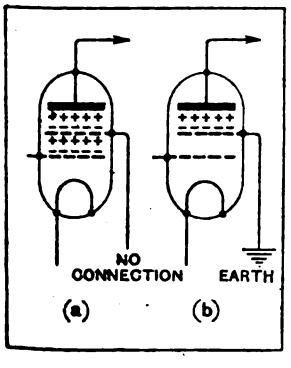
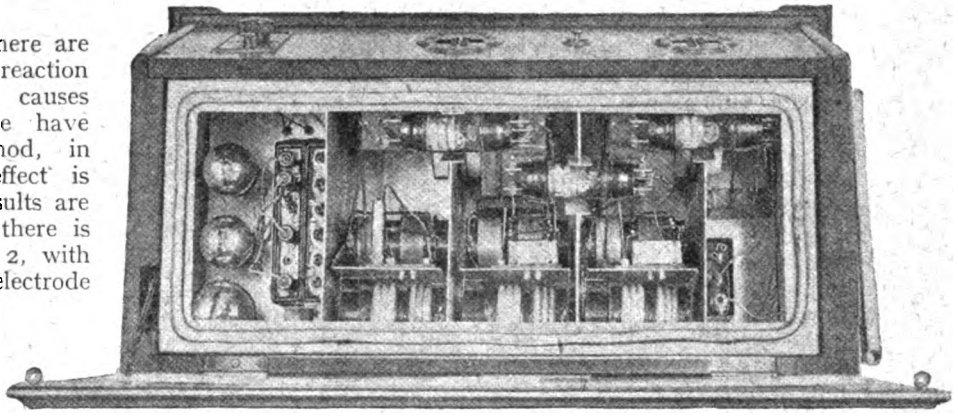


Fig. 4.—Effect of interposing a screen between plate and grid. In (a) the screen is not earthed and therefore fails to isolate plate and grid as the distribution of charges shows. In (b) no charge appears on the lower side of the earthed screen so that the grid is unaffected by charges on the plate (compare Fig. 2).

This is the principle upon which the screen-grid valve is built, the extra electrode being the screening grid interposed between grid and plate. It is necessary, of course, to ensure that not only the electrodes themselves, but also the leads running to them, shall be screened from one another, which is accomplished in practice by putting the valve through a hole in a metal screen and having grid and plate leads out through opposite ends of the bulb. The screening grid, together with these extra precautions, removes almost completely the reflex action of the plate upon the grid.

Nothing has so far been said about the structure of the screening grid, but in discussing its action it was tacitly assumed that it was a sheet of metal completely cutting off the grid from the plate. While this would undoubtedly be effective in preventing the plate from influencing the grid, and so in eliminating unwanted oscillation, a valve so made would hardly be satisfactory, for electrons from the filament would not be able to reach the plate at all! It is necessary, in consequence, to make the screen in the form of a perforated sheet or a fine gauze of wire through the meshes of which electrons can pass. By this compromise the perfection of the screening is marred to some extent, and a trifling amount of energy can be fed back, though not usually enough to set up oscillation.



A commercial receiver incorporating three screen-grid H.F. stages. Expensive, but of superlative performance, a receiver of this type is only made commercially possible by the screen-grid valve.

Effect of Screen on Valve Characteristics.

The screening grid is, in practice, not earthed directly, but through a large condenser, so that although high-frequency potentials cannot appear upon it, it can be raised to any desired d.c. potential. This arrangement offers the opportunity of utilising the screening grid for a second purpose in addition to that of preventing oscillation, for it is found that if it is connected to a tapping on the H.T. battery the characteristics of the valve are made very much better than those of an ordinary triode.

It is not difficult to see how this happens.[1] If we ignore the plate of the valve for a moment and think of the other three electrodes only, we have in effect an ordinary triode with the characteristics of a good member of its class. Variations in the H.T. voltage

[1] For the mode of presentation here adopted, the writer is indebted to "The Shielded Four-electrode Valve," by Capt. Round.

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The Passing of the Neutralised Triode.—

on the screening grid, which is acting as the plate, will alter anode current in the usual way, so that the valve impedance will not be very high. Variations in grid voltage will produce a change in plate current of the magnitude normally found with triodes.

If now we put on the plate a voltage that is about double that on the screening grid, electrons previously stopping at the screening grid will be pulled through its meshes to the plate, so that a current will make its appearance in the plate circuit at the expense of that in the screening-grid circuit. Owing, however, to the screening effect of the screening grid, the plate will only be able to divert electrons to itself at the last moment, when they have practically reached the screening grid, so that changes in plate voltage will have hardly any effect on the plate current. This is merely another way of saying that the A.C. resistance of the valve is high. But—and here is the point—the grid can still control the current flowing through the valve to the same extent that it did when the plate was out of use, so that the mutual conductance of the valve is unchanged. Since mutual conductance is the ratio of amplification factor to A.C. resistance, and the latter has been raised enormously while keeping the ratio constant, it follows that the amplification factor of the valve has also been enormously raised. The usual figure for a screen-grid valve is 200, as against the normal 40 of a high-amplification triode with a lower mutual conductance.

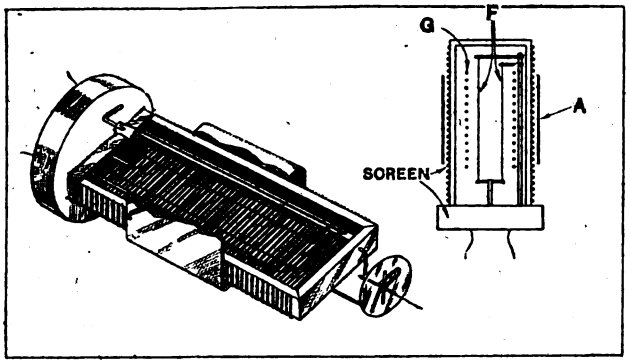

Fig. 5.—The arrangement of the electrodes inside a typical screen-grid valve. The inner or working grid G surrounds the filament F, the anode A being mounted outside the screen grid.

Thus the introduction of the screening grid, besides removing at its very source the chief cause of unwanted oscillation, has the further result of making it possible to attain greater amplification from the stage than was possible with the neutralised triode.

In the earliest screen-grid valves the screening was imperfect enough to permit oscillation to make its appearance as soon as the amplification of the stage was raised to about two-thirds of the maximum attainable from an ordinary valve neutralised, so that these valves offered no real advantage over the neutralised triode. In the latest models, however, the screening is much more nearly perfect, so that very high amplification can be reached before the tiny residual feed-back through the valve causes oscillation. Simultaneously, the characteristics have been improved, so that this high amplification can be realised quite readily in a practical receiver without any of the circuit complications associated with the neutralised triode.

The best of the 2-volt screen-grid valves can now provide, in quite an everyday set, an amplification of 120 times in a single stage with complete stability, while if special precautions are taken to minimise losses in the tuned circuits an amplification of over 200 times can be reached before magnification, by out-running the effectiveness of the internal screening, causes the old trouble of spontaneous oscillation to recur. In any set aiming at such high amplification as this it is of course quite necessary to isolate grid and plate circuits completely by enclosing one or both of them in a metal screening-box with a very well-fitting lid and soldered seams.

In conclusion, it is only fitting to draw attention once more to the vast strides that have been made since the original introduction of the screen-grid valve just two years ago, and to emphasise the fact that the neutralised triode, which served us so well for so long a time, and which gallantly held its own against the screen-grid valve in its early days, is now very definitely outclassed by its younger rival.

HOWLERS FROM DAVENTRY PROGRAMMES.

THE French versions of the Daventry programmes appearing in *L'Antenne* and other Paris papers are often funny, but have surpassed themselves in the last few weeks.

Misprints in English titles are, of course, frequent, and occasionally inspired (as, for example, the "Dank-Holiday" overture). One would have expected, however, that so well known an item as Ravel's "Ma Mère l'Oie" might have been recognised by the French translator, and not left as "Suite de Mère Goose"; or that the "Chant du Canot sur le Volga" might have got back into its normal French form; or that someone might have noticed that "Handel et la Harpe" is not a translation of "Handel and the Harpsichord." And the "third form" flavour of "Je suis toujours en amour avec vous" comes as a surprise in a French paper!

However, these are minor delights, as is also the (quite excusable) "Handel sur la Plage." A higher level is reached with (July 24th) Tchaikovsky's "La Beauté du Sleeping"; for the benefit of those whose French is classical it should be added that a "sleeping" (fondly believed, of course, to be the English expression!) is French for "sleeping-car," so that one feels that this suite should be hooked on behind the "Pacific 231."

And finally, "Bague, Cloches, Bague," an item in the 7.30 London and Daventry concert of August 3rd. Sceptics (though no one would ever have dared to invent this!) may see *L'Antenne* of Sunday, July 28th, page 724.

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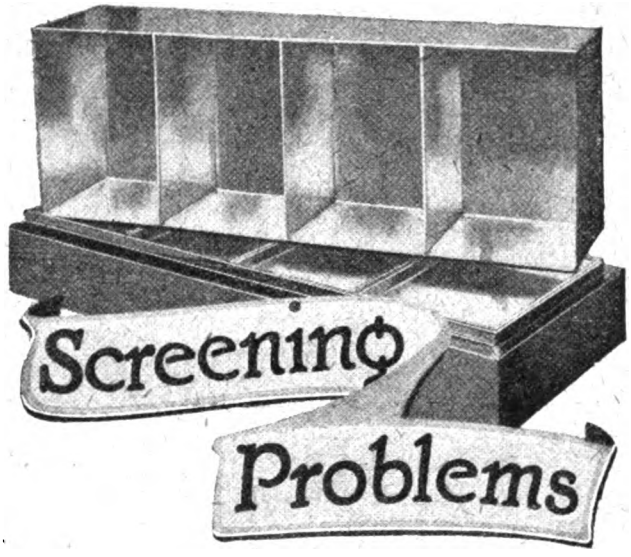

Some Practical Hints on Isolation of Circuits.

By H. F. SMITH.

TO the manufacturer of complete receivers the present-day need for extensive screening has probably been a blessing in disguise, as it has naturally inclined his mind towards the metal chassis plan of construction, of which so many successful examples will be seen at Olympia. The amateur sees the matter from an entirely different viewpoint: factory methods are obviously impossible for him, and, handy as he may be with his tools, sheet metal working is generally found to be beyond the scope of the home workshop.

Difficulties in the way of the constructor are gradually being smoothed away, but in any case he must reconcile himself to the fact that the sensitivity of his H.F. amplifier will be largely dependent on the effective isolation of each grid and plate circuit. Designers of screen-grid valves have played their part nobly by reducing internal inter-electrode capacity almost to vanishing point; it cannot be too strongly emphasised that their efforts are wasted unless those who use the valves take all possible precautions against unwanted external couplings.

There is another aspect of the screening problem apart from its application to H.F. amplification. If we are to have twin high-power stations a not inconsiderable percentage of the population of this country will find themselves so situated geographically that it will be a difficult matter to receive even one transmission without interference. In localities where the strength of incoming signals is greatly in excess of requirements it will clearly be an extravagance (for local alternative programme reception) to use H.F. amplifying valves, and in many cases a comparatively simple arrangement of tuned cascade filters, involving no maintenance cost, will be found to fill the bill admirably. Here is another application for screening: if the apparatus is to be disposed in a reasonably small space, fairly thorough isolation of individual circuits is found to be necessary.

Reverting to the question of screened H.F. amplifiers, it would perhaps be well to devote a few words to the proper method of distributing components among the various compartments. The skeleton circuit diagram of two high-frequency stages followed by a detector, given in Fig. 1, should serve as a guide to generally accepted practice in this matter. It should be observed that the H.F. valves themselves are external to the boxes in conformity with the usual arrangement where a considerable stage gain is anticipated: it is important that they should be so mounted that the plate and grid connecting leads should not exceed an inch or so in length. The conventional valve shield—virtually an extension of the internal screening—is recommended, but more or less as a safety measure; if the layout is carefully planned it adds but little to the maximum amplification attainable.

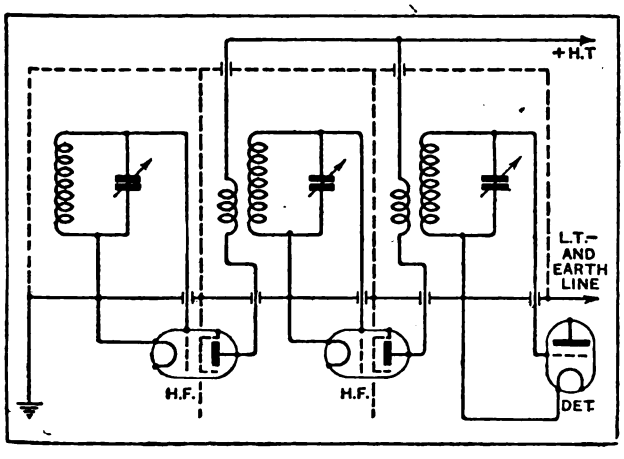

Fig. 1.—Circuit diagram of "2-H.F." receiver (omitting non-essentials) showing disposal of components in the screening compartments, which are indicated by dotted lines.

Aerial Circuit Screening.

It may be pointed out that it is by no means essential in every case to enclose the components associated with the first (or input) grid circuit; indeed, where a frame aerial is used as a collector it is obviously impossible to do so. If this circuit is unscreened still greater care must be taken to prevent feed-back from the output end of the set, and in consequence, it is advised that it should receive the same attention as the remaining grid circuits when circumstances permit. A reduction in direct pick-up is sometimes urged as a further reason for screening the aerial-grid coil and condenser, although it is to be doubted if this is valid.

In laying out a screened set there is a very natural tendency to overlook H.F. currents in the detector anode circuit and to be lulled into a false sense of security because, say, an H.F. by-pass condenser is connected directly between the plate and filament. Even if considerably more elaborate precautions than this are observed it is still necessary to look on the

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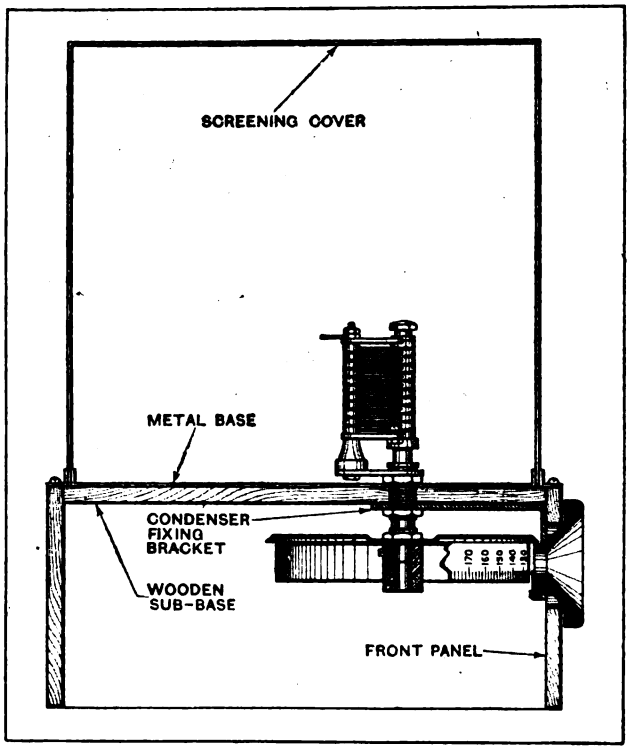
Screening Problems.—

entire anode circuit as a potential source of danger; without going to the length of recommending that it should be separately screened, it is advised that the components and wiring should be disposed so that they do not "couple" with any of the other H.F. circuits.



Method of mounting variable condenser with drum dial and friction drive in a "Wireless World" type of screening cabinet. The condenser is a new "Utility" product; the scale reading is visible through an aperture in the operating knob.

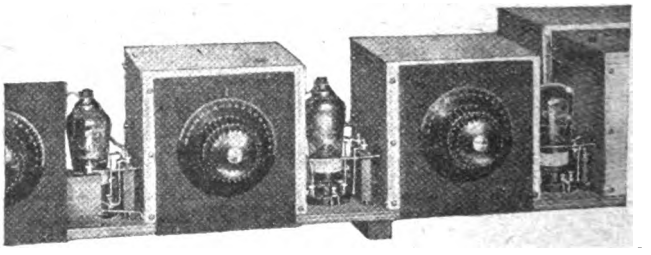
Leakage at Joints in the Screen.

Poor joints in screening boxes are a constant source of trouble; for instance, a set of conditions may be encountered where a shielded receiver is lacking in stability when an ill-fitting metal lid is in position, but is quite free from self-oscillation when the cover is entirely removed. This suggests that inadequate screening in certain positions can be worse than no screening at all, but, to prevent the formation of a wrong impression in the reader's mind, one should go on to say that, if overall H.F. magnification of the set under discussion is increased, a state of affairs will be reached where stability is unattainable until the lid is altered so that it makes a satisfactory electrical seal.

It would hardly be exaggeration to say that the progress of amateur radio during the past year has been hampered by difficulties more or less closely associated with screening problems. It is unfair to ask the manufacturer to produce, at prices within everyone's reach, different types of container for an almost infinite variety of sets, but we can fairly hope to see a range of perhaps three standardised sizes capable of accommodating any ordinary receiver. The type of metal cabinet suggested by the *The Wireless World* Technical Staff, and used for the "Kilo-Mag Four," was found to be suitable without any alteration as to dimensions for the "Record III." The writer has the Editor's permission to say that a four-valve receiver, to be described in the near future, and from which great things are confidently expected, will be housed in an exactly similar container. All this would seem to prove definitely that there is no insuperable difficulty in the way of using the same type and size of cabinet for a diversity of sets—always provided that the original basic design is so planned that the designer's style is not unduly cramped. *The Wireless World* cabinets certainly fill this requirement, and, modified by manufacturers to meet the exigencies of commercial production, it is likely that they will provide an almost complete solution of the screening problem. Their reception up to the present time has certainly been most encouraging.

Condenser Dials.

The variable condensers of each receiver built in this type of cabinet have been operated through a thumb-controlled dial. Those wireless users who profess an objection to this method of tuning may be interested to know that this disability—from their point of view—may be overcome by fitting a condenser of the pattern having a drum dial, and driven through a friction reduction gear by a panel knob. A component on these lines is the new "Utility"; perhaps the Olympia Show will disclose others capable of being fitted in a similar way The provision of a 4in. dial should enable the condenser to be mounted in a cabinet with a projecting base. A condenser of this sort should be easy to fit, but, of course, it will almost always be necessary to insulate the spindle and bush from the metal base.



A modification of the conventional method of screening, in which H.F. valves are mounted between spaced metal boxes. This spacing increases the effectiveness of shielding, particularly if the box joints are not completely closed.

When you Visit
OLYMPIA
CALL AT STANDS 38 and 39, where recent "Wireless World" sets are on view.

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Broadcast Brevities

By Our Special Correspondent.

Public Demonstrations of Television.—Brookman's Park on Trial.—Pacifying Scotland.

Where to See Television.

"And how shall we receive television?" is a legitimate question in view of the fact that the first tests from a B.B.C. station are to begin on Monday next, September 30th. In order to lose no opportunity of enabling Olympia visitors to view the results, the Television Development Company are installing a demonstration receiver in a building opposite the Exhibition entrance, and the test transmissions will be received here daily from 11 to 11.30 a.m. I understand that similar equipment will also be in operation at Selfridges and possibly at another well-known store. The first transmissions will consist of cinematograph films.

The B.B.C. wish it to be clearly understood that they are in no way concerned with the demonstrations beyond supplying the necessary transmitting station. Mr. Baird, therefore, has a free hand.

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Savoy Hill's Single Thought.

It is not often that the whole staff at Savoy Hill deigns to interest itself in the technical side of the Corporation's activities. During the past week, however, the whole battalion—musicians, programme compilers, porters, announcers—have been asking one question: "How are the Brookman's Park transmissions being received?" But the engineers, delighted though they may be at having roused the fickle interest of the layman, are cautious in their replies. They realise, as "Satisfied, Wanstead," may not, that a single transmission after broadcasting hours is no test of a regional scheme.

oooo

"London Regional" on Trial.

On the whole, the reports are gratifying, but, as I ventured to prophesy, there are some grumbles. From Pimlico comes the rebuke: "Very faint—not worth paying the licence," while Paddington, with more restraint, says: "Weaker." It will interest listeners in both these districts to know that a resident at Brookman's Park is full of praise for the Regional Scheme because a crystal set gives him excellent volume on a loud speaker. (Pimlico will be comforted by reflecting that Brookman's Park will be no place for wireless reception when London Regional No. 2 starts up.)

oooo

The Satisfied South.

Satisfaction with the signal strength of the new station is most marked in districts which are poorly served by the Oxford Street transmitter. In the East, Leytonstone and Mile End are both highly delighted, while the same feeling is expressed in the southern suburbs. Purley registers a definite improvement, while a correspondent in Guildford tells me that he must undoubtedly shorten his aerial to prevent overloading!

It is encouraging to hear from Welwyn, only six miles from the regional station, that while excellent quality is obtainable on a screen-grid three-valve set with frame aerial, there is little difficulty in cutting out signals when required.

oooo

Too Many Programmes?

With the prospect opening up before us of programmes on every side to suit every mood, it is disturbing to learn from South Africa that listeners are growing dissatisfied with broadcasting because there is too much of it. It is feared that too plentiful a supply sharpens the critical faculties of the listener to a degree which becomes unpleasant from the broadcaster's point of view. One journal, which seems to have the interest of the broadcaster at heart, urges a reduction of broadcasting hours, in the belief that the programmes would thereby be improved. Or would the result merely be the blunting of that cursed critical faculty?

Whichever way we look at it, there can be no doubt that the British regional scheme will enormously increase the burdens of the programme compilers.

oooo

Scotland Distrusts the Regional Scheme.

We have heard so much about the centralisation of programme effort under the regional scheme that it is hardly surprising that many areas in which local patriotism is strongly marked are beginning to eye the whole scheme with suspicion. Scotland particularly is concerned lest the victory of the trouser over the kilt be repeated in the realm of broadcasting by an unwholesome preponderance of "English" talent.

To allay all feeling of this kind, the Scottish Regional Director, Mr. D. Cleghorn Thomson, will broadcast from all Scottish stations on Tuesday, October 8th, explaining that the development of Scottish endeavour in music and drama will be more fully catered for under the regional scheme than ever before. It is to be hoped that, so far as is reasonable, the same policy will be observed in other parts of the country.

oooo

Play by "G.B.S."

Lovers of Shavian drama should note in their broadcast diary that Shaw's play, "Captain Brassbound's Conversion," is to be given from 2LO, 5XX, and other stations on October 16th.

oooo

America's "Cathedral" Studio.

A correct studio "atmosphere" has always been regarded in America as a vital necessity to the sensitive broadcast artiste, and many ingenious architectural devices have been employed to obtain various effects such as the "Palm Court" and the "Terraced Garden." Now Dr. M. Luckiesh, described as Cleveland's "lighting wizard," has devised a system of illumination for the National Broadcasting Company of America, which can transform any studio into a cathedral or a severe Roman forum by the turn of a switch.

The effects are obtained by concealed lights and cunningly designed shadows which give the studio walls the appearance of receding or advancing according to the requirements of the producer.

FUTURE FEATURES.

London and Daventry.

SEPTEMBER 29TH.—Harvest Festival Service from St. Giles' Church, Stoke Poges.

OCTOBER 1ST.—Excerpts from Queen's Hall Promenade Concert.

OCTOBER 2ND.—First General Assembly of Re-United Church of Scotland, S.B. from Edinburgh.

OCTOBER 4TH.—"The World We Listen In," a miniature revue by Holt Marvell.

Daventry Exp. (5GB).

SEPTEMBER 29TH.—Programme of Oratorio.

SEPTEMBER 30TH.—Queen's Hall Promenade Concert—Wagner.

OCTOBER 2ND.—Queen's Hall Promenade Concert—Brahms.

OCTOBER 4TH.—"Made in Brummagem," written by Graham Squiers, composed by George Barker, Fred Cecil, and Shirley Goodall.

Cardiff.

SEPTEMBER 30TH.—A West Country Programme.

Manchester.

SEPTEMBER 30TH.—Works by Gustav Holst.

OCTOBER 5TH.—"Calais to Dover," a farce by Gertrude S. Jennings.

Newcastle.

OCTOBER 1ST.—Local Opera.

Glasgow.

OCTOBER 1ST.—"Barbara Grows Up," a play by G J. Hamblen.

Aberdeen.

OCTOBER 4TH.—Light Orchestral Concert.

Belfast.

OCTOBER 4TH.—A Programme of Coleridge-Taylor's Music.

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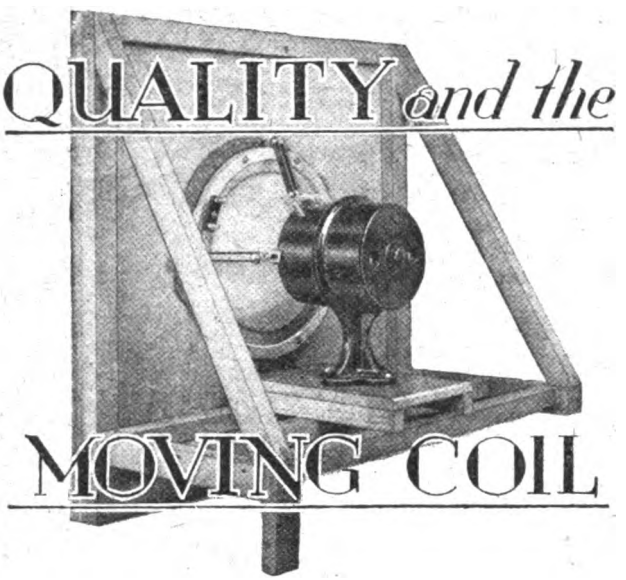


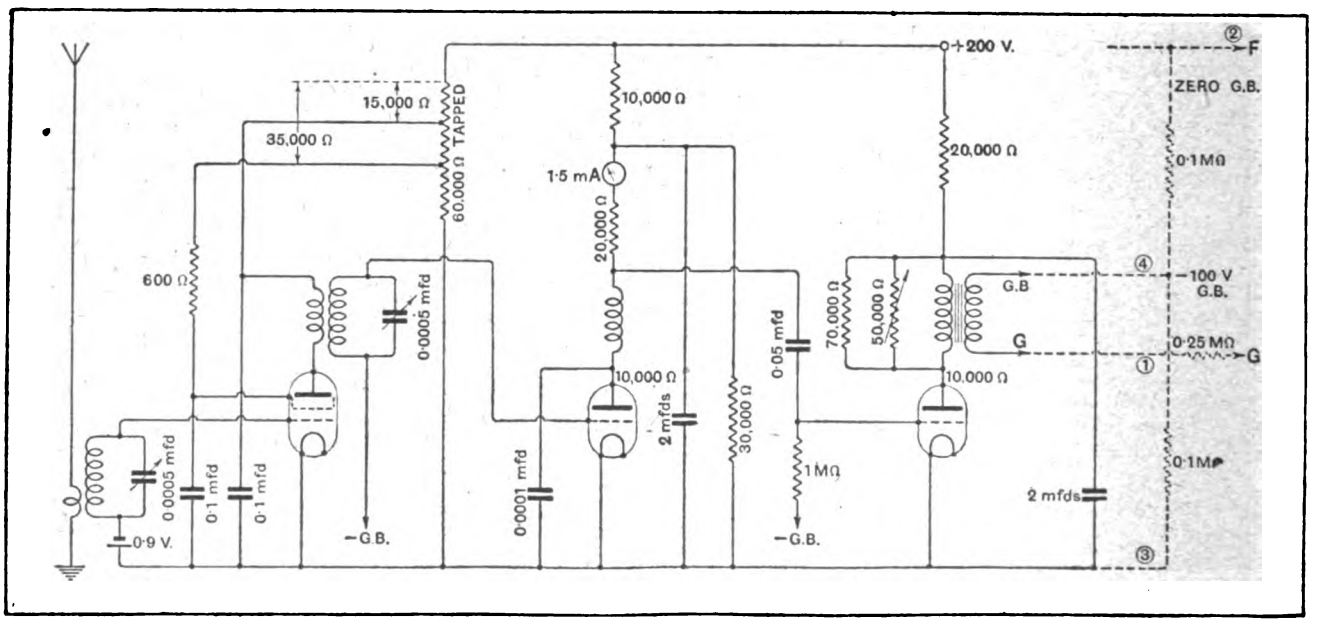
Some Facts on Obtaining the Best Reproduction.

By F. H. HAYNES.

UNQUALIFIED statements are inevitable when facts are to be recorded briefly. The points set out here are, however, not merely opinions but carry with them the endorsement of practical proof with experience dating back to the time when a commercial moving-coil loud speaker was unobtainable. Some of the results have been found by trial and error, and others are the proof of prediction, yet all are in agreement with theoretical reasoning.

To construct a set suitable for giving good quality reproduction with a moving-coil loud speaker, together with long-range reception, is the ambition of many an enthusiast. Eventually he learns that range and quality do not walk hand in hand. Long-range reception demands a generous H.F. amplifier, which, in collecting the distant signal, gathers atmospherics and heterodyning, the low-frequency vibrations of the former and the high-pitched whistles of the latter being particularly well produced by the moving-coil speaker. Such background noise cannot be tolerated. Selectivity is an essential to sensitivity, and to such an extent must it be introduced that the higher audio-frequencies carried by the side bands are lost. Experience clearly proves that both leaky grid detection and reaction must be avoided, but these aids to sensitivity are not wanted with a local station receiver.

An electric light supply is essential for the adoption of the output amplifier circuits given here; indeed, we must admit that without mains it is difficult to fulfil the requirements of quality reception. A 200-volt D.C. or rectified A.C. supply is needed to operate the three-valve receiver shown. No attempt is made at high stage gain in this receiver—in fact, rather the reverse is aimed at. It is scarcely necessary in this particular instance to use a complete screening box for the H.F. stage, a screen separating the apparatus of the grid circuit from that of the anode circuit being all that is necessary. Special low-loss coils are unnecessary, and moderately flat tuning is desirable. Input is controlled by adjusting the aerial turns, while a ratio of about 1 to 4 for the H.F. transformer will suit most valves, at the same time avoiding oscillation troubles. The use of an L.F. valve as an anode bend detector is also advisable. True, such a valve is very inefficient, but overloading of the subsequent stages must



The milliammeter in the anode of the detector is a comparative measure of signal strength. Assuming a fixed figure for percentage modulation with a given valve and grid bias, overloading of the subsequent stages is avoided by assessing a maximum meter reading determined by aural test or with the aid of microammeter and milliammeter in the grid and anode circuits of the output.

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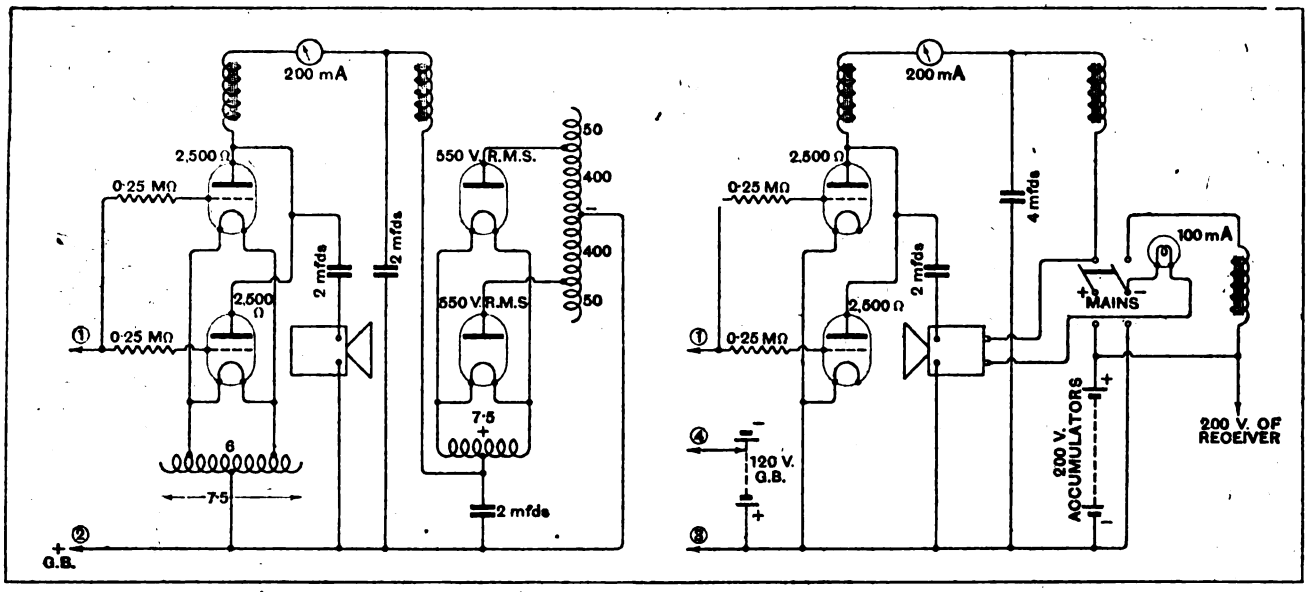
Quality and the Moving Coil.—

be carefully guarded against, while our aim is to preserve the upper frequencies. Such a low impedance valve might be followed by a special transformer coupling, yet put to suit the early valves is wasteful. To create an unnecessarily high anode voltage so as to provide, in the case of A.C. supply, a "free grid bias," impairs the life of the rectifier, and to obtain the 100 volts unloaded



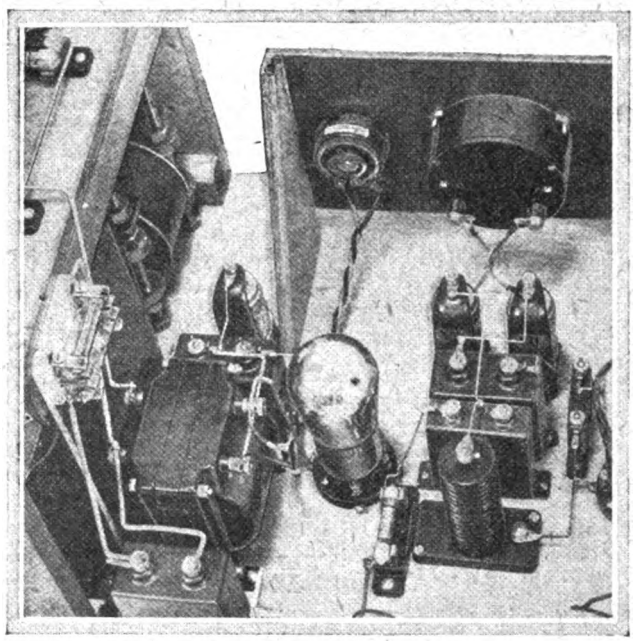
Output stage for use with A.C. supply. Grid bias is derived from the amplifier feeding the earlier stages. A separate arc rectifier energises the field magnet, neither smoothing nor floating accumulator being necessary.

Output stage for use with D.C. supply. An H.T. accumulator is charged from the mains and serves the earlier valves while it becomes series connected with the supply for feeding the output stage.

if the bass frequencies are to be preserved resistance coupling has much to recommend it. An unusually low value of anode resistance effectively avoids high-note loss. This anode bend detector valve is fed from a potentiometer as an alternative to a voltage dropping resistance because the anode current becomes several times greater on the tuning-in of the carrier.

A transformer-coupled stage follows the resistance coupled detector. The transformer, which should be selected with caution, should have quite a low ratio. Volume is initially controlled by adjusting the aerial turns, but as it is undesirable to reduce the input to the detector below certain limits, a second volume control is arranged as a by-pass shunt to the transformer primary. The output amplifier should be treated entirely apart from the preceding stages.

To break down the high anode voltage of the output biasing potential is not an economy with A.C. A separate rectifier should be employed for the early valves, use being made of this potential as shown in the diagrams for biasing the output stage. The high voltage mains circuits for D.C. and A.C. supply will be found self-explanatory.



Layout of the apparatus associated with the detector, showing the post-detector volume control and the milliameter which serves as a measure of signal strength.

Choke feed output as compared with the transformer prevents the signal currents from circulating through the H.T. supply. An output transformer is often the cause of distortion, while the only advantages it can bring are those of a more compact moving coil, and hence a smaller gap, and a reduction in the effect of capacity introduced by long extension leads. Generous gap width matters little if we have mains, and consequently plenty of energising current. At the same time, the need for a centring device is avoided. Many output chokes are far too meagre, and when passing the heavy D.C. anode current

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Quality and the Moving Coil.—

do not maintain a sufficiently high impedance at very low frequency.

A moving coil possessing the number of turns for "maximum undistorted power output" will render the speaker too sensitive for ordinary room conditions, while valve impedance must be high compared with that of the coil to render the total circuit impedance reasonably constant with change of frequency, the varying coil impedance being swamped by that of the valve. This does not mean that we must go out of our way and use high-impedance output valves or avoid the use of valves in parallel. We need a coil that is as light as possible and, all things considered, a winding of some 700 to 800 turns, 2in. in diameter, will suit the output amplifier shown in the diagrams. The more the turns the greater the falling-off of the frequencies at the upper and lower ends of the scale. The reasons for this are obvious in that the impedance of an inductance increases with frequency, while the back voltage set up by the generous excursion of the moving coil at the low frequencies also causes a reduction in the value of the alternating current. This latter condition cannot be remedied by weakening the field, for in order to produce the same signal output we should then require a coil of more turns, possessing increased inductance, and having, incidentally, a greater D.C. resistance and weight. It is therefore apparent that we need maximum flux density across the gap for quality reception. Thus, to weaken the field is unsatisfactory as a volume control, while it is equally unwise to shunt the moving coil with a variable resistance. A reduction in the plate circuit impedance due to shunting the coil may cause an output valve previously correctly adjusted to run into grid current and suffer from the troubles of overloading. To connect a resistance in series with the moving coil of such a high value effectively to cut down volume, while swamping the effects of the changes of coil impedance, is not recommended, and the only correct method is, of course, to reduce the grid swing applied to the output stage by the volume controls provided. A marked weakening of the bass results when volume control is attempted by the process of detuning. A rattling effect in moving-coil reception is more often due to overloading of the output valve than to a mechanical vibration in the loud speaker itself. Cotton-wool lightly packed between the centre pole and the moving coil will temporarily remedy the distortion due to poor centring without introducing buzzing or chattering noises.

WE WANT YOUR VOTE.

Every Reader Should Participate.

WE have already announced in previous issues the details of the Olympia Show Competition which *The Wireless World* is again arranging this year in connection with the Annual Radio Exhibition, and we wish to impress upon every reader individually that we want his vote to ensure that the results of the ballot are truly representative of the views of our readers as a whole.

It is really quite a simple matter to complete the entry form, which is to be found amongst the advertisement pages of this issue, and will appear also in our issue of next week. Every visitor to the Exhibition goes there, we believe, having in mind as one of the objects of his visit to form his own personal opinion as to what is the outstanding feature of the Show, and what are the best products in every class of apparatus exhibited. We ask every reader to pass on to us his choice by completing the Competition entry form.

Classification of Exhibits.

For convenience, we have divided up the exhibits into the following classes:—

(1) Complete receiver of five valves or more—that is to say, receivers exclusive of loud speaker and batteries—unless these should happen to be incorporated as part of the receiver.

(2) Complete receivers or amplifiers of four valves or less, similarly defined.

(3) Batteries of all kinds, including accumulators for both high- and low-tension.

(4) Mains supply units, both D.C. and A.C., and including those providing filament heating circuits.

(5) Loud speakers of all types. (6) Valves.

(7) Other apparatus not classified above; also component parts such as transformers, condensers, tuning coils, resistances, etc.

How to Enter.

The completed entry forms need not be sent to us until after the appearance of our issue of next week, to be dated October 2nd, but should reach us not later than Monday, October 7th. At our Stands, Nos. 38 and 39 on the ground floor of Olympia, letter-boxes are provided to receive completed entry forms from those who prefer to hand them in in this way instead of posting them.

Naturally those readers who are able to visit the Olympia Exhibition will be able to arrive at their decisions in the choice of apparatus in the various sections with the least difficulty, as they will see the apparatus at first-hand for themselves, but for those who may not be able to get to Olympia the competition is still open, and the three Show Numbers of *The Wireless World* may be expected to provide ample information to guide them in their choice.

We remind our readers that *The Wireless World* is offering £100 in prizes in connection with the competition, the first prize of £50 to be awarded to the competitor whose vote agrees with the opinion of the majority in the selection of the outstanding single exhibit and also in the largest number of classes, whilst in addition second, third, fourth, and fifth prizes to a total value of a further £50, in the form of vouchers for the purchase of apparatus, will be presented.

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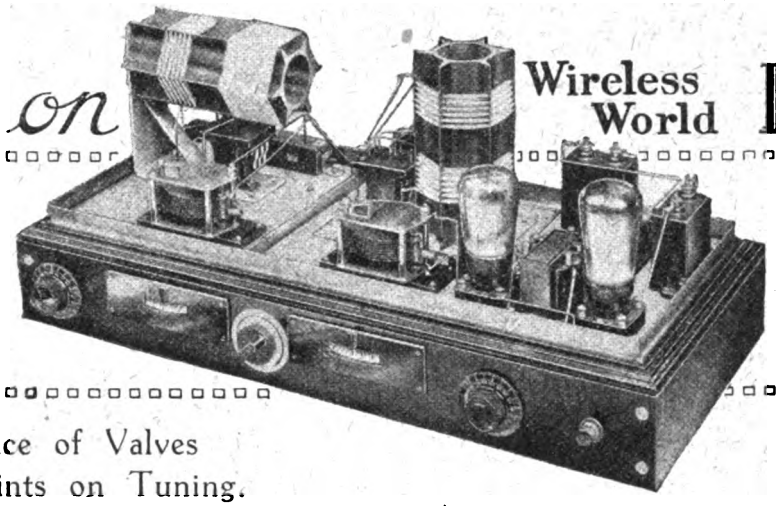
Notes on the Wireless World KIT SET



Choice of Valves and Hints on Tuning.

IN last week's article dealing with the circuit principle and the construction and wiring of the "Kit Set," considerations of space prevented the inclusion of dimensions relating to the special metal cabinet. The drawing given below is schematic and gives the leading dimensions only, such details as strengthening fillets in the corners of the wood base being left to the discretion of the individual. The fitting of the condenser dials will be greatly simplified if the front edge of the base is made detachable. Special attention should be devoted to the electrical seal between the bottom edges of the screening cover and the metal tray in the base. The method suggested in the issue of this journal for July 24th will give good results, provided the clearances are small, while the type of seal evolved by Messrs. Ritherdon and Co., Ltd., who made the original cabinet for this set, has given every satisfaction. The appearance of this cabinet may be judged from the accompanying photograph.

Coming now to the question of suitable valves, we will commence with a decision to concentrate on 2-volt valves only. In the first place, the idea of a 2-volt filament circuit is in keeping with kit set tradition, but this would not deter us from giving precedence to 4- or 6-volt valves if it were thought that these would give vastly better results. As a matter of fact, some of the best screen-grid valves at present available are to be found in the 2-volt series, the detector bias is capable of much finer adjustment when using a 2-volt filament circuit, and modern 2-volt power and super-power valves are capable of giving more undistorted volume than can be used in the average room. At one time the output valve was the weak link in the 2-volt range of valves, and many people still express a preference for the 6-volt series, though their requirements in the matter of volume may be quite modest. When it is mentioned that the "Kit Set" has been running a

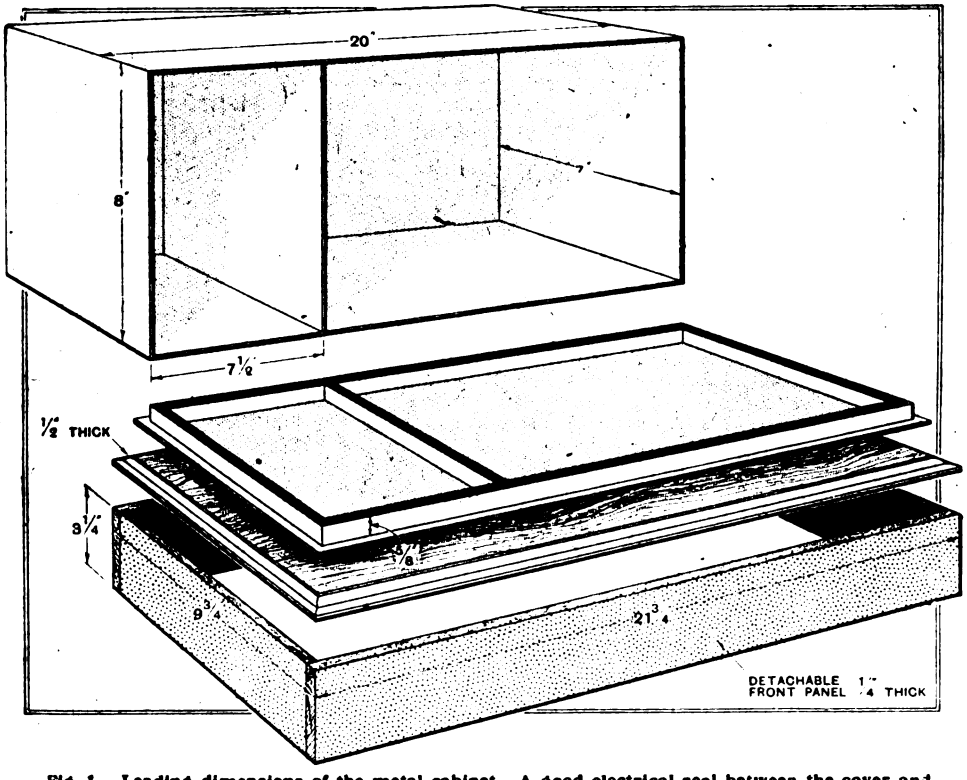


Fig. 1.—Leading dimensions of the metal cabinet. A good electrical seal between the cover and the metal tray is essential. The plinth is constructed of wood and should be provided with a detachable front panel.

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Notes on The Wireless World Kit Set.—

moving-coil loud speaker to capacity during the last few days with a "240" super-power valve in the last stage, it may be taken that such a prejudice is not founded in fact.

The ratio of the H.F. transformer permits considerable latitude in the choice of a screen-grid valve, and good results will be obtained with any valve with a nominal A.C. resistance of, say, 200,000 to 250,000

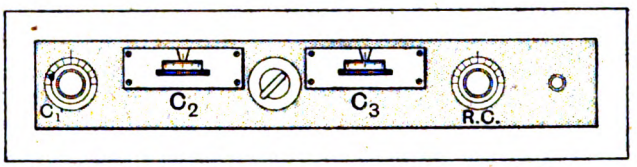


Fig. 2.—Key to the tuning controls. The on-and-off switch is on the extreme right, while the volume control rheostat is situated between the main tuning dials C_2 and C_3.

ohms, and amplification factor 200 to 250. Generally speaking, valves with an A.C. resistance above these figures will give greater selectivity at the expense of range, while below 200,000 ohms amplification will be increased at the expense of selectivity. Most modern S.G. valves are adequately screened, but if the valve chosen does not possess a low residual plate-grid capacity, instability will result. The upper limit for this capacity may be set at 0.02 micro-mfd.

The detector should be of the familiar "H.L." type with an A.C. resistance of about 20,000 ohms and an amplification factor of 20. A wide choice is presented by the valve makers, and generally speaking, the valve with the highest mutual conductance will give best results.

The type of output valve will depend on the volume required by the individual, and the battery power at his disposal. The first two valves will account for about 6mA. of H.T. current at 120 volts. An ordinary 2-volt "power" output valve with a 0.15 or 0.2 amp. filament and an A.C. resistance of 4,000 or 5,000 ohms will account for a further 6 or 8 mA., bringing the total up to 12 or 14 mA. This combination will satisfy most people, but a "super-power" valve with a 0.4 amp. filament and A.C. resistance of 2,000-2,500 ohms will give "moving-coil" volume for a total anode current for the set of 16 to 20 mA.

It is worth while to experiment with the setting of the potentiometer tapping (R_2 in the circuit and wiring diagrams of the original article) for on this adjustment depends not only the efficiency of the detector, but also the smoothness of reaction control. Most valves require a positive setting, but with valves in which grid current starts fairly early a terminal nearer the negative filament connection should give best results.

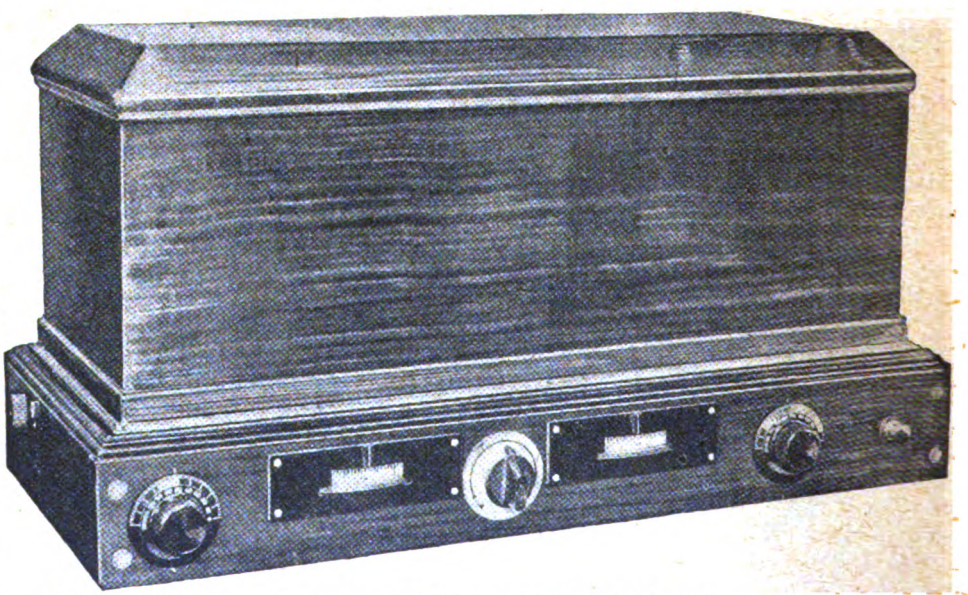
Further experiments with the tappings on the secondary circuit coils confirm the second turn on the medium-wave coil and the fifth turn on the long-wave section as the best settings for general use. They give an ample margin of selectivity for the Regional Scheme without in any way affecting the range of the set.

The prospect of four tuning controls may seem, at first sight, somewhat formidable, and, in fact, it is useless to expect results if the dials are twiddled at random. Success lies in systematic routine movements of the controls based on a proper understanding of the function of each dial.

Sequence of Tuning.

The tuning condenser C_2 (left-hand main tuning dial) is the keystone of tuning system. This condenser tunes the secondary (grid) coil of the coupled aerial circuit, and its setting is unaffected by alterations in the adjustments of other dials on the panel. It is for this reason that the scale readings of this condenser have been used in preparing the calibration chart in Fig. 3. The reader is strongly recommended to use a similar curve for his own receiver, starting with a few points for prominent stations and adding points as new stations are received.

Next in importance to condenser C_2 is the aerial tuning condenser C_1 (Fig. 2), controlled by the small dial on the extreme left of the panel. Leaving C_2 set, rotate C_1 until resonance with C_2 is indicated by a faint hiss in the loud speaker. Now bring C_3, the H.F. transformer condenser controlled by the right-hand main dial, into tune with the first two circuits and increase volume of means of the reaction condenser R.C. (small subsidiary dial on right), remembering that any alteration in the reaction setting will necessitate readjustment of the H.F. trans-



General view of the complete receiver. The metal cover is finished to resemble mahogany, and is practically indistinguishable from French polished wood.

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Notes on The Wireless World Kit Set.—

former circuit C_3. That, *in extenso*, is the complete process of tuning. It may sound complicated, but is essentially simple when epitomised into the following rule:—

When searching for stations divide the controls into two groups, "Aerial (C_1) and Secondary (C_2)" and "H.F. (C_3) and Reaction (R.C.)." Always keep C_1 and C_2 in step when moving across the wavelength scale and then tune in to the "C_1-C_2" group with C_3 and R.C. as with a simple reacting detector set.

The foregoing applies to the reception of distant stations. When tuning to the local station the quality can be modified to suit individual taste by varying the degree of reaction and experimenting with one or more of the circuits slightly off tune. Here the volume control rheostat can be brought into play with advantage. When using the Mazda S.G.215 valve in the first stage it was observed that the filament was somewhat "sluggish"; in other words, unless the rheostat was turned slowly the desired setting was easily overshot.

Selectivity and Range.

With regard to the range obtainable, the calibration curve speaks for itself. All these stations were logged at loud speaker strength on a 50ft. aerial at a place 1¾ miles from 2LO, where interference from electrical machinery is unusually severe. The following facts will indicate the degree of selectivity to be expected. On long waves Königswusterhausen (1,635 metres) was received clear of Daventry 5XX and Radio Paris, the two nearest stations on either side. On medium waves Frankfurt (390 metres) and Naples (332 metres) could be received without a trace of background from 2LO, while the volume from Toulouse (381 metres) was such that the slight background from 2LO did not interfere with the enjoyment of the French programme.

Knowing the adverse conditions under which these tests were carried out, we put forward this receiver with confidence for use in any part of the country.

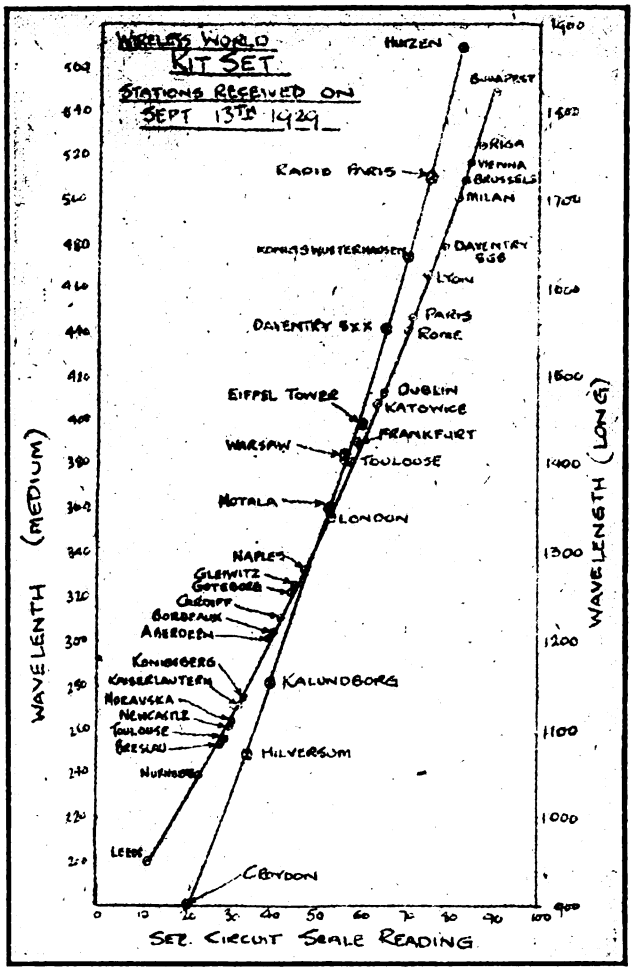

Fig. 3.—Stations received during the course of a single evening on a 50-ft. aerial 1¾ miles from 2LO, using a Mazda S.G.215 valve in the first stage.

NEGATIVE RESISTANCE.

The Explanation of a Quaint Phenomenon.

MANY users of receivers embodying a screen-grid valve in the high-frequency stage must have noticed that if the H.T. + connection is broken at the conclusion of a transmission, the receiver emits a feeble little squeak before subsiding into silence. It is quite a harmless phenomenon, but it may have puzzled others as much as it did the writer when he first came across it.

The cause is simple enough once it is pointed out. On breaking the H.T. + lead the anode voltage is not instantly reduced to zero, because there are large reservoir condensers which continue to supply a steadily falling voltage for a very appreciable fraction of a second. As the voltage on the anode of the screen-grid valve falls, it passes through a value a little lower than that by which the screening grid, by its separate connection to the battery, is still maintained. But it is well known that the screen-grid valve has a negative resistance when the voltage on the anode is a little lower than that on the screening grid, which implies that any coil connected in its plate circuit will be set into oscillation at the frequency to which it happens to be tuned.

In this way the plate circuit of the valve oscillates for an instant, and, heterodyning the station to which the set is tuned, causes the squeak. The squeak is faint because all the other valves in the set have a ridiculously low anode voltage at the moment when the oscillation occurs, while still being biased to suit the full voltage. They therefore hardly amplify at all.

Normally, when we say "a valve is oscillating," we mean that there are oscillations in its grid circuit. In the present case, although it is the first valve of the set that is causing the oscillations, they are entirely restricted to its plate circuit, so that the oscillations cannot be radiated by the aerial or cause offence to other listeners.

A. L. M. S.

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CURRENT TOPICS

Events of the Week in Brief Review.

"WIRELESS WORLD" AT OLYMPIA.

To avoid the rush, visit *The Wireless World* Olympia stands, Nos. 38 and 39, as early as you can. The "W.W." receivers on view include "Three Valve 'Kit' Set," "The New Kilo-Mag Four," "The Record III," and "The Foreign Listener's Four." In addition, "The Hum-Proof D.C. Eliminator" is available for inspection.

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THINK OF A NUMBER.

The *Daily Mirror* is offering radio equipment to the value of £200 in prizes for successful forecasts of attendances at the National Radio Exhibition.

oooo

ALL-ELECTRIC SHOW IN PARIS.

Like the British Radio Exhibition, the Paris Salon, organised by the French Radio Manufacturers, and to be held in October, will take rank as an "all-mains" show. It is expected, writes our Paris correspondent, that all-electric sets will be the main feature.

oooo

RADIO AT SHIPPING EXHIBITION.

Visitors to the National Radio Exhibition at Olympia will find several devices of wireless interest at the Shipping, Engineering, and Machinery Exhibition, which runs concurrently in the Main Hall, Olympia, until Saturday next, September 28th. An example of the automatic alarm receiver is on view, besides other marine wireless apparatus.

oooo

WHY ALGIERS HETERODYNES.

Radio-Algiers has recently been accused of heterodyning 2LO. Apart from the proximity of wavelength (Algiers works on 351 metres), the trouble may be due to the fact that the new transmitter at Algiers provides an aerial power of 12 kW. The makers, who also equipped Radio-Paris, have adopted the system of modulation at low power as used by the new B.B.C. regional station.

oooo

SETS ON APPROVAL.

Radio dealers in the United States are waking up to the fact that the "sets on approval" business requires a good deal of watchfulness. The discovery has been made that many listeners make a practice of "joy riding," securing a set for the stipulated month's trial, afterwards returning it as unsatisfactory. By patronising a sufficient number of manufacturers in this way, a listener can enjoy free broadcast reception for many months.

WHAT HAPPENED NEXT?

True story from New York:—

Station Director: This is WJZ.

Voice on 'Phone: What's that?

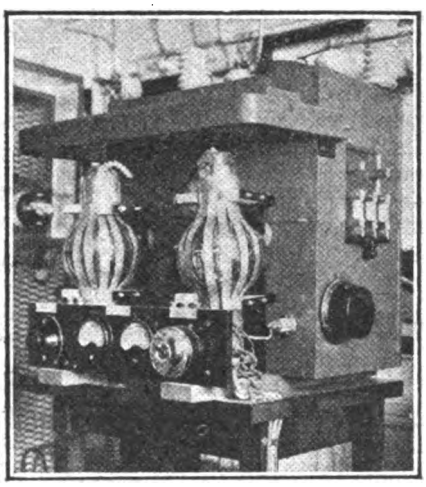
S.D.: This is WJZ.

V.O.P.: Sorry, can't get you. Would you spell it?

oooo

120 KILOWATTER FOR PARIS?

Paris, which is already overstocked with broadcasting stations, is threatened with a new arrival in October—"Radio Banlieue"—which, it is stated, will work on 120 kilowatts "at the start"! One trembles to imagine what power will be developed when Radio Banlieue really "gets going."



"WHILE YOU WAIT." A new Marconi short-wave transmitter which can be attached to an existing set, using the same H.T. supply. It is on view at the Olympia Shipping Exhibition.

A COMPLIMENT TO WIRELESS OPERATORS.

Except on occasions of shipwreck, wireless operators receive few bouquets, but a tribute to their accuracy and efficiency is contained in the annual report of the director of the Meteorological Office. It is stated that, although all messages relating to weather are sent in figure code, and frequently during the busiest periods, in 4,476 reports, each consisting of eight groups of five figures, transmitted during the year, Atlantic operators made only two mistakes in every 1,000 figures.

A BRAZEN SPECIMEN.

A "pirate" fined at Mistley, near Ipswich, was detected through having lodged a complaint with the B.B.C. regarding local oscillation.

oooo

ROOM FOR DEVELOPMENT.

Lithuanian Post Office returns show that there is one broadcast receiver to every 220 persons. Kovno, the capital, with a population of 195,000, contains only 1,279 wireless sets

oooo

THREE-YEAR WIRELESS COURSE.

A three-year course in Radio Communication is included in the syllabus of the Northampton Polytechnic, St. John Street, London, E.C.1. A free prospectus can be obtained on application.

oooo

WIRELESS OPERATORS' UNION.

Mr. T. J. O'Donnell has been appointed general secretary of the Association of Wireless and Cable Telegraphists in succession to the late Mr. E. R. Tuck. Mr. O'Donnell has been secretary of the marine section since 1920.

oooo

PROGRAMMES FROM ICELAND.

The Iceland Government has signed a contract with the Marconi Company for the construction of a new high-power broadcasting station at Reykjavic, the capital of the country. The transmitter will have an aerial power of 15 kW., and special circuits will be incorporated to enable it to be used for telegraphic transmission, as well as broadcasting. The work is to be completed in time for the thousand years' anniversary of the discovery of the island, to be celebrated next June.

oooo

HOPE SPRINGS ETERNAL.

A rather startling contribution to the controversy regarding the question of erecting steel pylons on the South Downs for the conveyance of electric power is contained in a letter in the correspondence columns of our esteemed contemporary, *The Sussex Daily News*. The writer says: "The question is, which is better—to put up with disfigurement for a number of years for the immediate gain of cheaper electricity for rural districts, or wait until this can be obtained at a still further reduction in price, owing to the great save of the capital costs of pylons and cables, which will be obsolete as soon as wireless can be used?"

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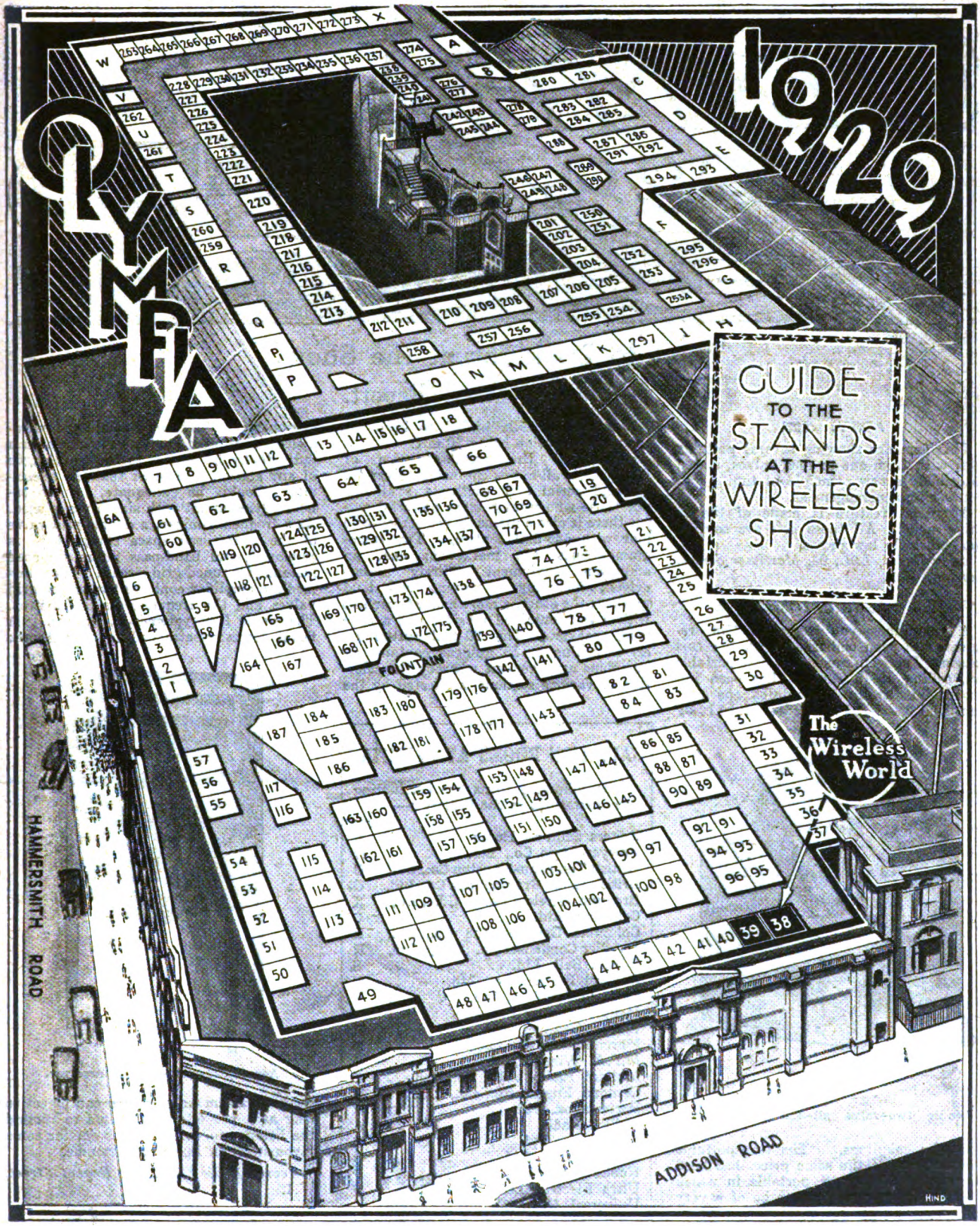

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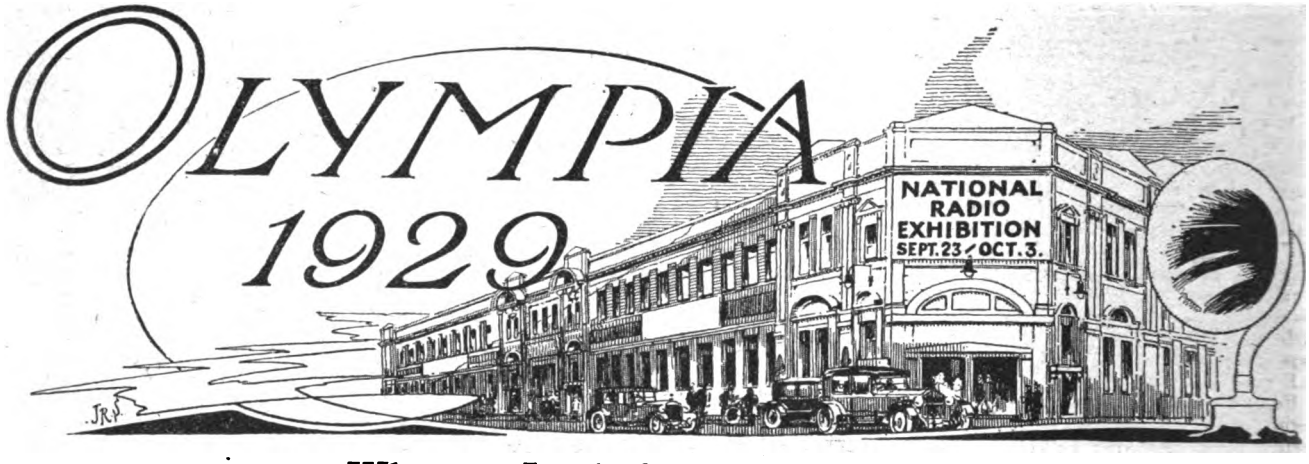

What to Look for at the Show.

A Stand-to-Stand Report.

ADEY. (297)

This firm are showing several portable sets, with from one to four valves, stated to embody a new principle of tuning and a new circuit arrangement.

A special feature is made of the 2-valve model. All these sets are sold at comparatively low prices.

Adey Radio, Ltd., 99, *Mortimer Street, London, W.*1.

AEONIC. (73)

A comprehensive programme in receivers has been embarked upon for this season. The well-known suit-case portable set, selling at 16 guineas, has been improved in detail. It contains the conventional two H.F. triodes linked by

Aconic two-valve all-mains receiver.

aperiodic couplings. The transportable Five, selling at the same price, has been retained, while a new portable in which the selectivity is claimed to be of a very high order has been introduced. There is a single screen-grid valve, followed by a detector and two L.F. magnifiers. The valves are carefully biased to keep the anode consumption below 10 mA.

Selling at the popular price of £12 15s. an all-mains cabinet receiver for external aerial and earth is available. For those who want a more powerful output there is also a mains-driven screen-grid four with one-dial control. Two radio-gramophones are marketed; one, an ambitious equipment entirely mains-driven, including a moving coil loud speaker; the other, a more modest machine with a self-contained receiver and a cone loud speaker. The 20-push-button receiver selling at 35 guineas contains an ingenious arrangement whereby the selection of various stations is effected by the key-operation of twenty semi-fixed mica-dielectric tuning condensers which can individually be pre-set to the wavelength of any station. In order that the selectivity should be adequate, a super-heterodyne circuit with six valves is used. As a frequency-mixer, a double-grid valve of the neutralised space charge type is employed, and band-pass filters are used instead of a tuned-grid circuit. The intermediate amplifier contains two screen-grid valves and the frequency is 650 metres. The single L.F. valve is a pentode. A novel accessory attached to each Aeonic

Aeonic 20-push-button receiver.

set is an alarm watch which can be set to ring at a pre-determined time to remind the listener to switch on his set for some favourite item in the programme.

Aeonic Radio, Ltd., 90, *Regent Street, W.*1.

AMPLION. (164 & 187)

Complete Amplion receivers, now shown for the first time, will naturally be

AUDITION ROOMS AT OLYMPIA

The following firms are conducting demonstrations in the Gallery :—

	Room
Bakers Selhurst Radio	L
Bowyer-Lowe Co., Ltd.	W
British Thomson-Houston Co., Ltd.	U
British Radio Gramophone Co., Ltd.	G
Brownie Wireless Co. of G.B., Ltd.	X
Celestion, Ltd.	C
Columbia Graphophone Co., Ltd.	N
Dubilier Condenser Co. (1925), Ltd.	R
Edison Bell, Ltd.	S
General Electric Co., Ltd. ..	K
Graham Amplion, Ltd.	E
Igranic Electric Co., Ltd. ..	P1
Kolster-Brandes, Ltd.	H
Marconiphone Co., Ltd.	D
M.P.A. Wireless, Ltd.	O
Mullard Radio Valve Co., Ltd. ..	T
Ormond Engineering Co., Ltd. ..	M
Perfectavox, Ltd.	V
Philips Radio	A
Pye Radio, Ltd.	B
Reproduction, Ltd.	Q
Rooke Bros., Ltd.	P
Ultra Electric, Ltd.	F
Universal Gramophone & Radio Co., Ltd.	I

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Stand-to-Stand Report.—examined with more than common interest. The following description applies primarily to the battery-fed model, although all the sets are of similar design.

The receiver is built on a cast aluminium chassis, and is enclosed in a metal cabinet finished in a dark and unobtrusive colour intended to harmonise with most schemes of furnishing. It employs a screen-grid H.F. valve and leaky grid detector with reaction, followed by resistance- and transformer-coupled note magnifiers. Automatic grid bias is provided for the first three valves, and there is elaborate H.F. filtering (screened in a separate metal box) between detector and L.F. amplifier.

Volume control is effected by varying aerial coupling by the swinging coil method, and provision is made for reducing input to a very low value if desired. The set is "decoupled" in a most thorough manner, and should be quite immune from troubles brought about by high-resistance batteries. It has two edgewise turning dials arranged side by side so that they can be operated simultaneously; both scales are calibrated in wavelengths.

Provision is made for connecting a pick-up across the first L.F. grid circuit. This device is inserted in such a way that one side of it is at earth potential, and advantage is taken of this by fitting a flexible pick-up lead having a braided metal covering.

The A.C. model is similar in essentials, but is fitted with A.C. valves in the first three stages and parallel P.625's at the output end. The built-in power unit includes a Westinghouse metal rectifier.

A radio-gramophone, including a similar receiver, is also produced.

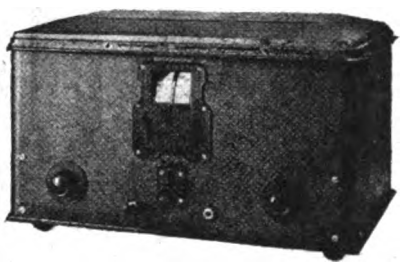
Turning to loud speakers, we find that the Amplion "Lion" cabinet models are considerably reduced in price, and that a new "Standard Cabinet Cone" with balanced armature movement has been introduced. This model has provision for adjusting the impedance of its windings to suit different valves.

The new Amplion pick-up is supplied either as a unit or with tone arm or volume control. The latter gadget operates on the potentiometer principle, and has an extra resistance (which may be short-circuited if required), so that the control of volume may be distributed over a large part of the resistance scale.

An insensitive type of pick-up, intended for cases where considerable amplification is available, but where the device must be operated at a distance from the amplifier, is also manufactured. Its windings are of low resistance, and consequently the disturbing effect of capacity in long leads will not be evident.

Amplion receivers and loud speakers are demonstrated at 9, Maclise Road, near Olympia.

Graham Amplion, Ltd., 25-26, *Savile Row, London, W.*1.



The New Amplion receiver.

ATALANTA. (236)

Apart from the Atalanta screwdriver, already well known to readers, this firm are exhibiting several other devices.

The Atalanta chuck is a handy holder for such small tools as taps and reamers; it is supplied with three collets to accommodate tool shanks up to ¼in. diameter. It is rotated by turning the knurled collar; the knob remains stationary in the palm of the operator's hand.

Every amateur mechanic—and even the professional—knows how difficult it is to drill a hole diametrically through round metal or ebonite rod. The Atalanta drilling jig makes the task easy. This simple device consists of a pair of steel blocks, with cross V-section grooves, held together by a pair of dowel pins. It has a guide for the drill.

A handy tool-set for the radio constructor is also produced. It comprises a soldering-iron, hammer, files, two pairs of pliers, scriber, and centre punch, all mounted by spring clips in a wooden rack, and costs 12s. 6d.

Atalanta, 1-3, *Brixton Road, London, S.W.*9.

AUTOMATIC COIL WINDER & ELEC. EQUIPMENT CO. (229)

An ingenious coil-winder machine is being exhibited which will not only measure and cut the wire to a predetermined length, but also will insert insulating material between each layer during the process of winding. A great deal of interest will undoubtedly attach to this machine, which is the outcome of many years of experiment.

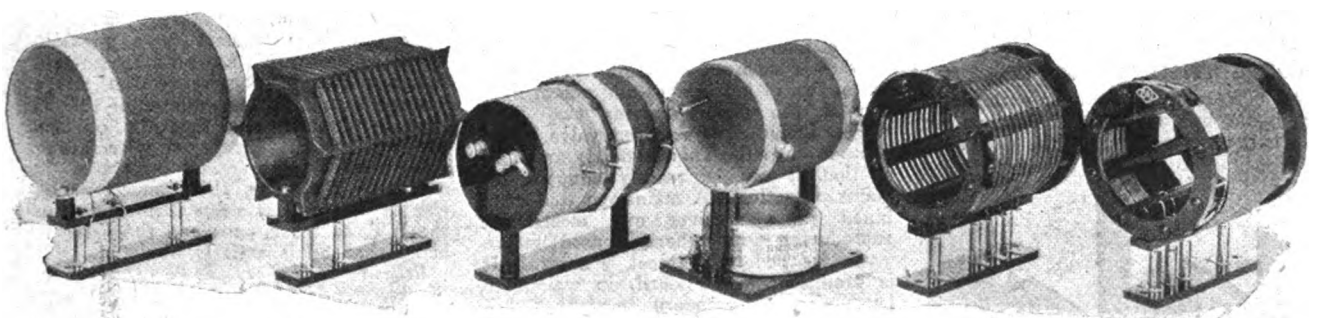
An entirely new model of a hand machine will interest the manufacturer, the retailer and the repairer alike, as the price is small compared with that of the automatic production. It will wind up to 3,000 revolutions per minute. There are other winders capable of working at 6,000 revolutions per minute. The Avometer, the well-known all-purpose meter, which will measure all ranges of volts, amps. and ohms likely to be met with in receiver technique is exploited by this company.

Another exhibit is the Slektun inductance coils which have, for this type of winding, a comparatively low high-frequency resistance.

*Automatic Coil Winder and Electrical Equipment Co., Ltd., Winder House, Rochester Row, S.W.*1

B. & J. (233)

The activities of this firm are almost entirely devoted to the production of tuning coils and in particular the coils that are specified and the various designs put forward for the home constructor. On a rough count there are no fewer than fifteen different types of coils, all beautifully finished so that the set builder can be assured of success in following a design by purchasing these ready-made coils. It will interest the set constructor to peruse a list obtainable at this stand setting out the many types of coils used in the construction of the receiving sets described in the various journals. In the majority of cases, and particularly is this true of highly efficient receivers, the performance of the set is entirely dependent upon the care which has been exercised in making the coils. Prices which appear to be reasonable are asked for the coils, and the service of supplying them removes an unavoidable weak link in the presenting of designs which are intended to entail only the assembly of components. Screens and



Specimen B. & J. coils for use in the making up of sets described in the "Wireless World."

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Stand-to-Stand Report.—

screening boxes also form part of this exhibit. As a guide to price, a set of coils for the "Screened Grid Regional" receiver is 35s. For the "Foreign Listener's Four" (broadcast band) 30s., and for the "New Kilo-Mag Four" (covering both ranges) 45s.

To cater for those listeners whose sets prove insufficiently selective with the starting of the Brookmans Park transmission, the B. and J. wavetrap has been introduced. Its selective low-loss coil is Litz wound.

B. and J. Wireless Co., Athelstane Mews, Stroud Green Road, London, N.4.

BAKELITE. (255)

While the many interesting mouldings to be seen at this stand illustrate the considerable advance the application of bakelite is making in the radio industry, one does not expect to find any conspicuous new developments. The new bakelite laminated sheet is of interest to every set maker as an alternative to the materials commonly used for radio panels. Apart from good appearance its principal merit is durability.

Bakelite, Ltd., 68, Victoria Street, London, S.W.1.

BEAVER. (287)

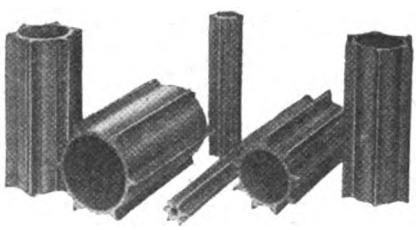
This firm factors the best known products of the more important radio manufacturers. Attention, in general, is being given to portable sets, and in particular to the Celebro five-valve receiver. This is contained within a suit-case and finished in solid hide, and sells at 12 guineas, or in blue rexine at £12. The conventional circuit containing two aperiodically coupled H.F. valves and a regenerative grid detector is employed.

A wide range of components is also to be seen on this stand.

Beaver Electrical Supply Co., 5, Great Chapel Street, W.1.

BECOL (BRITISH EBONITE CO.). (21)

The modern H.F. amplifier with single stage gains up to 500 times depends for its efficiency as much upon the design of

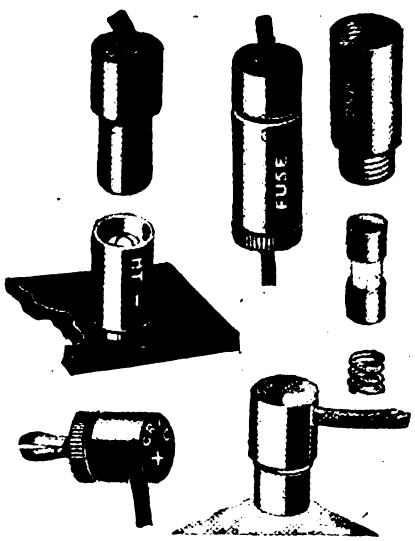


A range of Becol ribbed ebonite formers.

the tuned circuit as upon the characteristics of the valve. The desiderata for the optimum length and diameter of winding to produce an inductance of high dynamic resistance have been well understood for the last few years, but it has not been so well appreciated until lately that a winding mostly surrounded by air, such as results from the use of a ribbed ebonite former, has a very low high-frequency resistance indeed. Furthermore, the dielectric losses in good ebonite are small. For these reasons the 3in. and 4in. ribbed low-loss formers being exhibited merit attention, for with a Litz stranded conductor tuning coils can be wound to a dynamic resistance of over 300,000 ohms.

Ebonite sheet in matt, polished, and mahogany-grained finishes, is being shown together with rods, tubes and mouldings of various sizes.

British Ebonite Co., Ltd., Nightingale Road, Hanwell, W.7.



Belling Lee connectors for use in H.T. leads, grid bias and the anodes of S.G. valves.

BEETHOVEN (MONTAGUE RADIO INVENTIONS). (52-54)

Five models form the range of the Beethoven sets. There are three portables, two of four valves and one of five; one of the former having two H.F. stages, including a screened valve and a pentode output. This model is arranged so that it can be readily adapted for mains operation. A mains-operated combined radio receiver and electrically reproducing gramophone housed in an attractive pedestal cabinet is shown. It is produced, as standard, in walnut to harmonise with modern furnishing, but may be obtained in a wide variety of period designs. Radio reception is provided by an enclosed frame aerial followed by two H.F. stages, including a screened valve, a detector, and two L.F. stages. In the output are two parallel connected valves. The loud speaker is of the moving coil type. A pilot lamp on the operating panel indicates the switching on of the set. Long-range reception is claimed for the radio receiver.

Montague Radio Inventions and Development Co., Ltd., 117-119, Regent Street, London, W.1.

BELLING-LEE. (263 & 264)

The products shown cover a definite field which embraces all forms of devices needed for making the terminal connections to wireless apparatus. Apart, therefore, from the well-known Belling-Lee bakelite shrouded terminals we find at the stand H.T. and grid battery connectors, spade terminals and connectors carrying fuses. Orthodox designs have been departed from, and careful thought has been given to ensure that the connectors meet all practical requirements. Thus we find that the battery wander plugs are very much shorter than formerly. This modification renders them particularly suited to the conditions met with in portable set construction where very little space is available above the H.T. and grid batteries. Another refinement is the bringing out of the wire connector from the side of the insulating piece so as to avoid an acute turn which may eventually lead to breakage, while the exposed flat top conspicuously carries the marking. There are no side screws on any of the connectors, neither is there need for the use of a screwdriver when fixing the lead. Frayed ends are also avoided. An important development is the substitution of "D" section hard-drawn prongs in place of the old method of saw cutting a circular pin. By this means plugs are easily inserted, hold tight, and make reliable connection. Plugs and sockets are available for the jointing of flexible leads, and are so arranged with the aid of a sleeve that no metal parts are exposed when a connector is drawn apart. The same refinement is to be found in a range of wander plugs intended particularly for use in the construction of battery eliminators. These plugs are available for internal fuses. These are glass mounted and arranged to be readily replaceable. A new departure is to be found in spade terminals, where in place of the plain metal connector formerly used we now find a spring clip.

Of particular interest is a press-on anode connector for use with screen-grid valves. The lead carrying the anode voltage terminates on a connector that is entirely shrouded, so that the obvious danger of this H.T. carrying wire falling into contact with other apparatus is avoided. By using this connector the risk of burning out valve filaments when the L.T. switch is open and the valve is being changed is entirely obviated.

Belling and Lee, Ltd., Queensway Works, Ponders End, Middlesex.

BENJAMIN. (31)

Benjamin activities largely centre around the production of bakelite valve-

Benjamin turntable. It is fitted with collapsible feet on the underside.

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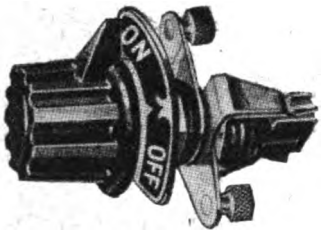
Stand-to-Stand Report.—

holders. The range is extended to meet modern requirements and new Benjamin types are available to suit indirectly heated and pentode valves. In addition



Benjamin rotary switch.

to the present type of plunger switch there is now a new rotary type. It has a snap action and is secured with one-hole fixing which carries an "on" and "off" indicating plate.

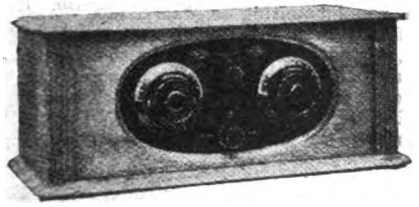
A turntable no less than 9in. in diameter is a new introduction. A unique refinement is the fitting of collapsible feet, which, not being required for indoor use, are folded inwards beneath the turntable, yet their adoption is almost essential when elevating a receiver used out of doors. The price is 7s. 6d.

Benjamin Electric Co., Ltd., Brantwood Works, Tariff Road, Tottenham, London, N.17.

BOWYER-LOWE. (130 & 131)

A newcomer to the range of Bowyer-Lowe receivers is a five-valve transportable. It is of the vertical type with tuning panel in a recessed compartment above the loud speaker grille. Tuning is by single dial, two other controls being for wavechange and volume. The price is £16 16s.

A popular Bowyer-Lowe receiver of last season, the "Pentovox-Three" employs a screen-grid H.F. stage with a pentode output. In addition to the two reduction geared tuning controls provision is made for the use of reaction.



Bowyer-Lowe Pentovox Three.

Including valves, H.T. and grid bias batteries, and four-volt L.T. accumulator, the price is £11 13s. 6d.

The already well known receivers, the "Vox Populi 3" and the "Screened 4," are now available with mains equipment permitting of their use with either A.C. or D.C. supply.

The Bowyer-Lowe Co., Ltd., Radio Works, Letchworth, Herts.

BRITISH GENERAL MFG., CO. (107)

An aerial-tuning unit for the 220-2,000-metre waveband, which proved popular during last season, has been slightly modified and reduced in price from 18s. 6d. to 14s. 6d. A three-valve battery-operated receiver for outside aerial and earth with enclosed loud speaker is a new exhibit selling at £15.

The "Midget" transformer will prove useful in portable sets and where space is a consideration. Bakelite mouldings, which form part of the exhibit, are now manufactured by this firm.

British General Mfg. Co., Ltd., Brockley Works, Brockley, S.E.4.

The "Adaptogram" pedestal cabinet.

BRITISH RADIO GRAMOPHONE CO. (155 & 157)

The British Radio Gramophone Co. are specialists in combined wireless and gramophone sets, but also produce apparatus for radio without a record turntable. An example of this is the Craigwell Model 12, which is a self-contained detector-L.F. set requiring only the addition of an external aerial and earth.

The Adaptogram is a gramophone-style cabinet fitted with a Garrard spring motor and turntable and space for any receiver of average dimensions. It is, of course, intended for those who wish to adapt their sets for gramophone work in a tidy manner, without straggling wires between set and batteries and between turntable and set.

The Craigwell Radio Gramophone, Model 37, is typical of the less-complex type of instrument of this class. Designed for an external aerial and earth and battery feed, it includes a three-valve detector-L.F. set, a built-in double linen diaphragm loud speaker, Garrard double-spring motor, and a B.T.H. pick-up. The instrument is supplied in oak or mahogany cabinet, and is of reasonable size—22in. wide, 19in. deep, and 41in. high. A mains-driven model is available.

The more ambitious and expensive radio gramophones designed for mains supply are fitted with parallel output valves and a moving coil loud speaker to the purchaser's choice. Swinging frame aerials are built into the side doors, and, where desired, electrically driven turntables are fitted.

A 4-valve portable, with a tuned H.F. stage (screen-grid valve) has just been introduced. This new model is of particularly clean design, and includes what is, apparently, most effective screening.

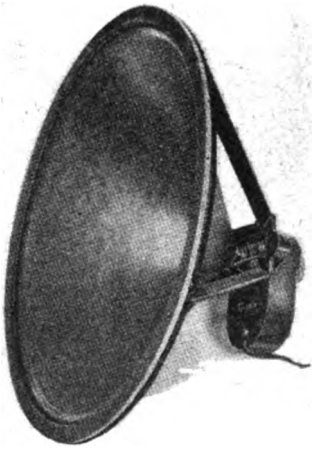
The British Radio Gramophone Co., Ltd., 77, City Road, London, E.C.1.

BROWN. (213-215)

In a demonstration of the new Vee reed-driven cone unit the output from two LS5A valves in parallel having about 50-volts grid swing failed to cause distress from overloading. From this it will be clear that the power-handling capacity of this unit is well above the average, which is explained when a study of the shape of the reed and pole pieces is made. Normally the magnetic pull on the reed varies as the square of the distance between the reed and pole-piece. In the Vee reed the angle of approach relative to the pole is not direct, but is a trigonometrical component, therefore the reed can be set nearer to the pole and yet have a bigger amplitude of movement without collapsing.

The reed is mounted on a double phosphor bronze suspension, giving ample flexibility, and the drive is direct rather than radial. The price of the unit is 25s.

The new "Duplex" loud speakers, of which there are three models, contain the Vee unit and cones of various diameters. The latter have a special construction, in that the cone is straight-sided at the centre but towards the periphery there are strengthening corrugations and the expansion is logarithmic. It is claimed



The Vee unit complete with cone chassis by S. G. Brown.

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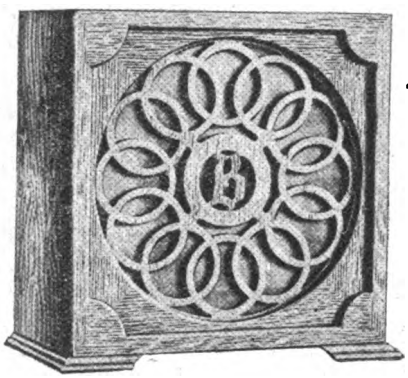
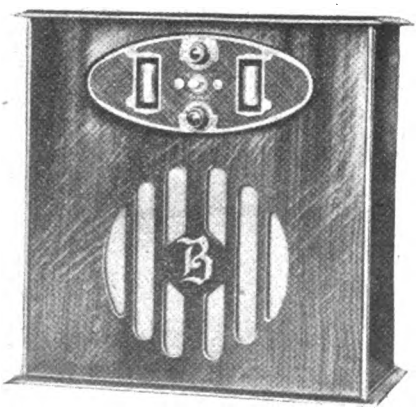
Stand-to-Stand Report.—that this design assists "shock absorption." The V.10 Duplex speaker with 10in. cone in a well-finished mahogany or oak cabinet sells at £5 10s.

A kit set for battery operation, in which simplicity of construction has been made a fine art, is available at £12, including self-contained loud speaker but excluding valves and batteries. Another constructors' set, suitable for operation from A.C. mains, is priced at £20.



The new Brown Duplex loud speaker with the Vee unit.

The A.C. eliminator for this receiver is also put out in the form of parts for home construction, and is designed in accordance with accepted modern practice for the feed of the three valves, which are respectively screen-grid, regenerative leaky-grid detector, and power output. There is a type B set which has a cabinet of different shape, not containing a loud speaker, but with ample room for H.T., L.T., and grid bias batteries. The tuning inductances used conform to *The Wireless World* practice and are wound on 3in. ribbed formers, and careful attention has been paid to the optimum ratio of diameter to winding length. It would be difficult to make a mistake in assembling the Kit receiver in the five distinct stages which are explained on coloured charts. The wooden baseboard has the shape of each component marked on it, and successive stages of assembly are associated with



A self-contained Kit set by S. G. Brown. A screened-valve H.F. stage is included.

different coloured leads. There are only seventeen wires to connect, and even the necessary tools are provided.

A handsome screen, resembling a fire screen, has been specially designed for use with the Vee unit and cone chassis (the latter sells at 15s.); it stands 2ft. 7in. high, and can be purchased for 42s.

The type "A" L.F. transformer, with an inductance of 200 henrys and a uniform curve from about 40 to 5,000 cycles, is retained in the 1930 programme, whilst a new smaller model—type "B"—with an inductance of 54 henrys at 1 mA. costs 17s. 6d.

There are four moving coil loud speakers; model A, for accumulator field excitation, consuming ½ ampere at 6 volts, is £9, including input transformer. Model B, sells at £6 17s. 6d. without transformer. Model C, wound with a field for D.C. mains, is £7 12s. 6d., and the necessary input transformer for the low-resistance speech coil is £1. The fourth model has a permanent magnet.

S. G. Brown, Ltd., Western Avenue, North Acton, W.3.

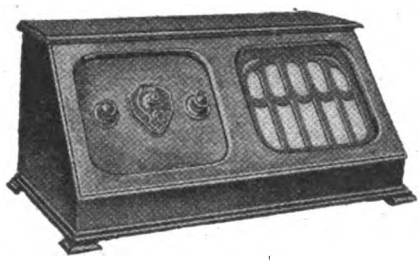
BROWN BROS. (34 & 35)

Although this stand is principally of trade interest in that a complete range of receiving sets by the leading manufacturers is to be found, considerable interest attaches to the extensive variety of accumulator charging equipments which have been brought together. One cannot do better than examine the various types of plant being shown here when interested in the problem of battery charging on a commercial basis.

Brown Bros., Ltd., Brown's Buildings, Great Eastern Street, London, E.C.2.

BROWNIE. (143)

Two new Brownie receivers are now seen for the first time. They might be



Brownie Dominion Console.

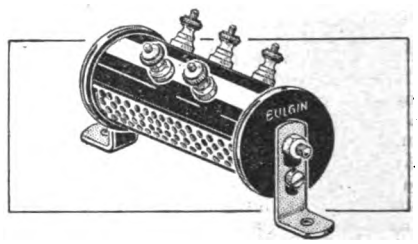
described as attractive sets, admirably suited to typical home requirements and offered at popular prices. The "Dominion III" is a detector with reaction followed by two L.F. transformer-coupled stages. The sloping front panel carries slow motion dials, and the cabinet is mahogany. A useful feature is the provision of a battery compartment. The price without valves is £5 17s. 6d. The other new model is the "Dominion Console," which includes a self-contained loud speaker as well as batteries. The price is £9 without valves.

Brownie Wireless exhibit in addition to wireless components, a crystal set, which indicates that this form of reception is by no means dead, and particularly is this observation true now that a high-power transmission is available for London listeners.

Brownie Wireless Co. of Great Britain, Ltd., Nelson Street Works, Mornington Crescent, London, N.W.1.

BULGIN & CO. (295 & 296)

A comprehensive range of components under the trade names of "Decko," "Deckorem," and "Bulgin," is being put on the market for this season.



Bulgin heavy duty tapped resistance.

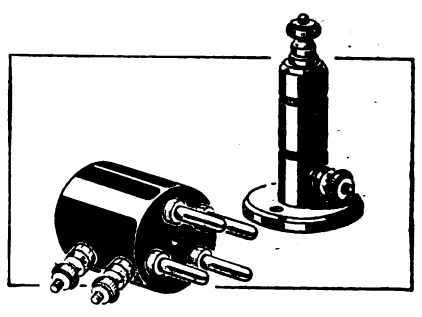
New baseboard-mounting decoupling resistances for screen-grid valves having resistances of 600, 1,000 and 2,000 ohms, should have extensive application now that stage amplifications of 100 or 200 times are the rule rather than the exception. These resistances have terminal connectors, are non-inductively wound, and sell at 1s. 6d. each.

For experimenters and dealers alike, a valve-holder in which the anode connector is broken and the ends are brought out to two terminals for the series connection of a milliammeter, should prove useful for testing plate current.

For inclusion in eliminators where plate currents up to 25 mA. have to be handled, there is a series of tapped heavy-duty wire-wound resistances, covering the range 1,000 to 100,000 ohms—the prices varying from 9s. 6d. to 12s. 6d. The small heat dissipation that may take place is assisted by the air-cooled frames, which are a standard fitting on every model.

A panel-mounting tell-tale lamp, fitted behind a ruby lens which only projects ⅛in., is a new component, as is also a frame aerial spacer for the home constructor. A set of four of these, made in bakelite and having ten slots, sells for 1s. 3d.

Among the many hundreds of com



On the left is the Bulgin valve-holder with split anode connection; on the right is a non-inductively wound 600-ohm decoupling resistance.

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Stand-to-Stand Report.—

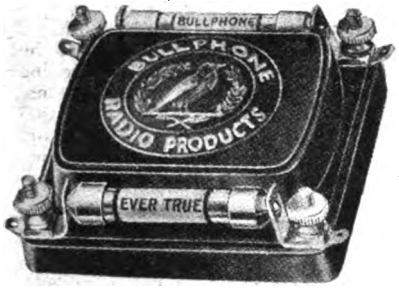
ponents listed by this company, mention may be made of the shock-proof mains connectors, flash-lamp fuses of especial value in metal oxide rectifiers, a high-frequency choke, and a heavy-duty potential divider.

A. F. Bulgin and Co., 9-11, *Cursitor Street, Chancery Lane, E.C.*4.

BULLPHONE. (60)

The loud speakers produced by this firm are retained, and a range of components has been introduced. These include a dual range coil wound on a ribbed bakelite former. Two aerial tappings are provided, and the unit is handy for mounting on a baseboard behind a panel. It has a push-pull switch operated by a control rod adjustable as to length. Plug-in aerial and anode coils, of which the windings seem to be well-proportioned, are also exhibited.

An R.C. unit in a neat bakelite case is also shown; the resistances and condenser have normal values, the former being of the grid leak type. Other products are L.F. transformers, fixed



Bullphone R.C. unit.

condensers, grid leaks, valve-holders and a neat binocular choke with a small external field, selling at 4s.

Bullphone, Ltd., 38, *Holywell Lane, Great Eastern Street, London, E.C.*1.

BURGOYNE. (50 & 51)

Three Burgoyne receivers are shown. First there is the "Pentode" model, which has for some while been the standard Burgoyne portable receiver. It is referred to as a "straight five," and comprises two triode H.F. stages, valve detector, and two L.F. stages, the output being a pentode. Faithful musical reproduction is claimed for this set, the loud speaker being a Burgoyne product. High grade components are used in its construction, and the H.T. battery consumption has been adjusted to about 7.5 mA. At a small extra cost a rejector is fitted to facilitate the cutting out of a local station. Supplied in a genuine hide case the price is £19 19s., inclusive of royalties.

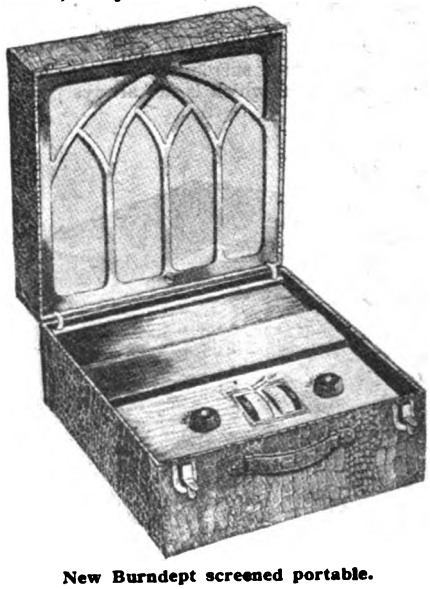
Next there is a four-valve model, the Burgoyne "Screened Four" de luxe, which is seen for the first time at the exhibition. The H.F. stage is a screen-grid amplifier, followed by detector valve, resistance-coupled L.F. stage, and transformer to pentode output. The two tuning condensers are operated by edgewise drum controls, arranged to give quick and slow motion simultaneously on both condensers. In addition to the use of reaction as a volume control a potentiometer is also provided for this purpose. The two wave ranges are obtained by a three-position switch, which includes the "off" position. The loud speaker unit is new and

The Burgoyne S.G. de Luxe.

has been specially designed for this receiver. H.T. consumption is 8.5 mA. A good feature is the inclusion of a calibration chart which, incidentally, shows the actual settings for over sixty stations. The case is of dark blue crocodile hide with nickel-plated fittings. Panels and grille are of polished walnut. The price complete is £25 4s.

Lastly, there is a mains-operated set which is indicative in its design of the trend in portable receiver construction It is an entirely self-contained four-valve set, utilising the new indirectly heated valves.

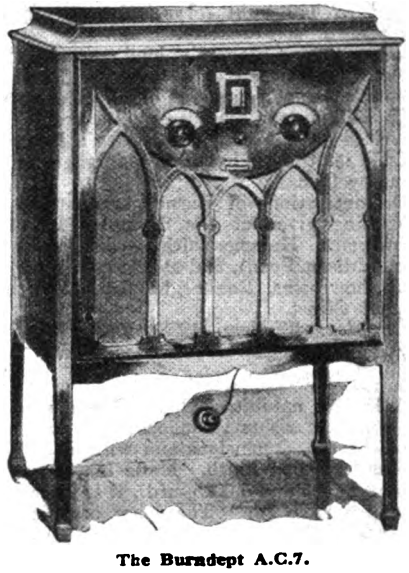
Burgoyne Wireless, Ltd., 34A, *York Road, King's Cross, London, N.*1.



New Burndept screened portable.

BURNDEPT. (144-147)

The new "A.C.7" is from every aspect an interesting example of modern receiver design. Mounted in an upright pedestal cabinet with built-in loud speaker and frame aerial, it includes two screen-grid H.F. stages, anode bend detector, resistance-coupled to the first L.F. amplifier, which is followed by a pair of push-pull output valves. The seventh valve is a rectifier for H.T. supply; grid bias is provided through a Westinghouse metal rectifier. The three tuning condensers are operated by a single control, a "trimming" condenser being connected across the frame for final adjustment. The tuning dial is calibrated directly in wavelengths, and there is a four-position switch providing for reception of three wavebands (from 200 metres upwards) or for gramophone reproduction. Construction is on the metal chassis principle.



The Burndept A.C.7.

Frame aerial and loud speaker (the latter is of the double stretched linen diaphragm type) are built up as a unit, and can be swung through about 65 degrees by rotation of a knob mounted in an external position.

Indirectly heated valves are used in the earlier stages, with directly heated triodes (P.625a) in the output sockets. A radio gramophone of similar design is manufactured.

The "Universal Screened Five," a table model receiver for general requirements, comprises a single H.F. stage, grid detection with reaction, followed by resistance- and transformer-coupled L.F. stages with push-pull output. Extreme sensitivity has been aimed at in the design, which includes such features as a three-position selectivity switch, three wave ranges, and a pre-detection volume control. An output milliammeter is fitted as an extra refinement. This set is supplied either for battery or A.C. mains feed.

The new "Screened Portable" is a

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Stand-to-Stand Report.—redesigned version of its well-known prototype. All valves are now completely enclosed, and their new arrangement is particularly economical in space. The receiver proper is built on an aluminium sheet frame, and a considerable improvement in sensitivity is claimed. As in the case of the "A.C.7," a linen diaphragm loud speaker, made under Air-Chrome licence, is included. A 118-volt H.T. battery of greater capacity than formerly is now fitted.

A new pick-up, of the type in which the needle acts as the armature, has just been produced. Minimum record wear, elimination of needle scratch, and extreme compactness are features of this new device, which can be supplied with a separate volume-control unit.

All the principal Burndept components are retained, with, in several instances, improvements in detail. For instance, the inductance of the H.F. choke is now raised to 150 millihenrys, without any increase in self-capacity.

The "Air-Chrome" loud speakers already mentioned are now sold as separate instruments. A table model, with a diaphragm measuring 14in. square, is priced at £4 4s.; there is also a large console instrument having a diaphragm of 18in. by 23in.

Demonstrations of Burndept apparatus are being given at the Olympia Motor Showrooms, Hammersmith Road (opposite Addison Road), and at the new West End showrooms, Roxburghe House, 283, Regent Street.

Burndept Wireless (1928), *Ltd., Eastnor House, Blackheath, London, S.E.*3.

BURTON. (36 & 37)

A leading exhibit of this firm is a new type of logarithmic condenser, of very small overall dimensions and with an exceptionally good finish. Made in capacities of 0.0003 and 0.0005 mfd., it is priced at 6s. and 6s. 3d. The space occupied behind the panel is approximately 2½in. by 3in. A cheaper and somewhat larger model, with aluminium end plates, is also shown. All Burton condensers have cone bearings, and the feature of an adjustable "band brake" is retained.

Edgwise condensers are often mere adaptions of components intended to be operated by the conventional knob and dial; this statement cannot be applied to the new Burton semi-gang condensers, of which the parts are clearly designed for their special purpose. The assembly consists of two condensers, with the direct drive drums arranged side by side so that both can be operated simultaneously by a single finger. Fine individual control is effected through a second pair of discs mounted outside the main drums. The aperture disclosing the scales is arranged at an angle suitable for easy reading. Single condensers on the same plan are also manufactured.

An L.F. transformer is a new product of this firm. Made in ratios of 5 : 1 and 3 : 1, it is mounted in a brown bakelite case, and has a heavy stalloy core, the laminations being "stepped" so as to provide the maximum amount of core to the bobbin on which the windings are carried. The price of this component is 10s. 6d.

A complete range of anti-capacity switches with from 1 to 5 poles, has just been produced. The design follows well-tried and proved practice. Other new components are binocular and single chokes, priced respectively at 5s. 9d. and 3s. 9d.

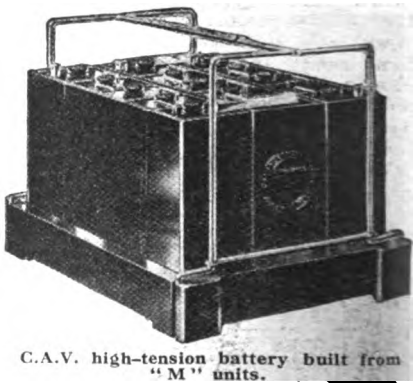
Several complete receivers have been introduced. The "Empire Three," a detector-L.F. combination in a wooden cabinet, sells at an exceptionally low price, considering its good finish and appearance. Another set, fitted with a switch for changing-over to gramophone reproduction, embodies an H.F.-detector-L.F. three-valve circuit, with screen-grid high-frequency valve. There is also an all-mains det.-L.F. three-valve set in which indirectly heated valves are used.

C. F. and H. Burton, Progress Works, Bernard Street, Walsall.

C.A.V. (120)

A very complete range of high- and low-tension accumulators are being exhibited. For portable sets there is being shown an "all-position" jellied-acid battery from which the egress of drops of acid is impossible. All parts of the plates are always surrounded by electrolyte, a condition which is not always possible with free acid. The jellied-acid is not a solid mass but has a cohesive honeycomb structure which ensures free distribution of the gases. Above the plates is placed a glass wool absorbent pad, which arrests acid spray, feeds the electrolyte with moisture, and confines the jellied-acid to the surface of the plates. To keep the pad thoroughly moist a little distilled water should be added about once a month. Size for size the ampere-hour capacity of these cells is no less than that in the free acid type, for no separate acid trap compartment is necessary.

New "M" type 10-volt H.T. accumulator unit (C.A.V.).



C.A.V. high-tension battery built from "M" units.

The new "M" type H.T. accumulators in 10-volt units are so shaped as to ensure an air space when they are grouped side by side or in tiers to make up a high-voltage battery. The cell containers are moulded in an acid-proof material used in car batteries. There are three capacities available, namely, 2,500–3,000 and 10,000 mA. hours, priced respectively at 5s., 6s. 3d., and 12s. per 10-volt unit, or 18s. 9d., 23s. 3d. and 42s. per 30-volt unit.

The A.C.M. type mass-plate cell, which has proved very popular, is being shown again at this exhibition. The cells have extra heavy plates, which are specially designed to give small discharges over long periods, and are, therefore, particularly suitable for operating low consumption valves. They can be left without attention for periods of several months without detriment. A 2-volt cell of 20 amp. hours sells at 4s. 6d. As an alternative to celluloid containers, the 2-volt

C.A.V. all-position jellied-acid cells for portable sets.

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Stand-to-Stand Report.—

range of Acton glass accumulators are to be recommended. The plates are not of the mass type, and are suitable for larger discharges. A cell with an actual capacity of 60 ampere-hours is marketed at 15s. 6d.

There are accumulators on this stand for every wireless purpose.

C. A. Vandervell and Co., Ltd., Warple Way, Acton, W.3.

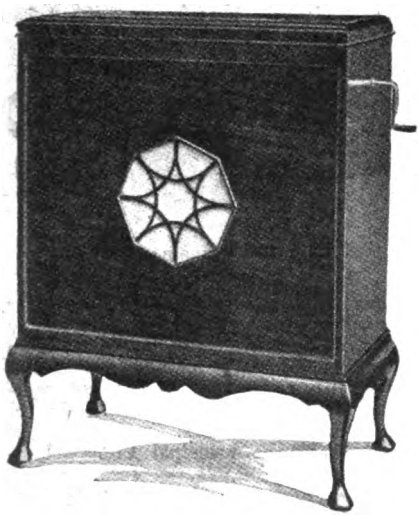
C.W.C. (COOK'S WIRELESS CO.). (223)

Receivers both of the portable and cabinet type, also a radio-gramophone, are to be seen on this stand. The C.W.C. cabinet transportable receiver has an internal pivoted frame aerial, so that for orientation the whole set does not have to be moved. Including royalty, batteries, and all accessories, this self-contained four-valve screen-grid receiver sells at £31 10s.

The C.W.C. 5-valve portable set is one of the smallest on the market—its dimensions being 15in. × 15in. × 7½in. A horizontal panel at the top ensures that undue stooping is not required when operating the set on the ground. The price complete is £22 10s.

There is a popular 5-valve portable receiver conforming to more conventional layout and dimensions at £16 10s. complete, and a range of 2-, 3-, and 4-valve cabinet receivers from £5 5s. to £16 5s. The 4-valve radio-gramophone being shown is self-contained with enclosed frame aerial and batteries, whilst the gramophone motor is spring-driven. The circuit incorporates the well-tried combination of tetrode-triode-pentode. The price is £45.

Cook's Wireless Co., Ltd., C.W.C. Works, Ipswich, Suffolk.



Radio gramophone with screen-grid and pentode valves manufactured by C. W. Cook's Wireless Co.

CAMCO (CARRINGTON MFG. CO.). (270 & 271)

Cabinets of every description for outside aerial sets, portable sets, and loud speakers are exhibited on this stand. The "Master" cabinet accommodating panels measuring 21in. × 7in. or 18in. × 7in. is especially suitable for an all-mains receiver. The lid is hinged, there is a loud speaker compartment which will take most of the popular cone chassis, and there is room for an eliminator. It should be mentioned that this cabinet is suitable for the Osram and Mullard Kit sets.

A loud speaker cabinet by Camco.

The "Popular" pedestal cabinets, for panels measuring 18in. × 7in. or 21in. × 7in., are well finished and will harmonise with the furniture in a living room; they can be supplied in finished oak or mahogany. The lid is hinged, the baseboard (supplied) is 10in. deep, and there is a separate battery compartment with removable flap; the overall height is 34in., and the price £4 10s. For those desiring to construct their own portable set a special cabinet is marketed with overall dimensions of 18in. × 17in. × 7½in., accommodating a panel of 16in. × 7in., with an actual opening of 12in. × 4½in. A 12in. cone can be used concealed behind a 9in. fret backed with silk. A removable ply frame is included to carry the aerial and batteries. The price in oak is 48s.

A suit-case to house a portable set is priced at 45s. The lid contains an ornamental grille to hide the loud speaker, and a removable frame for the enclosed aerial is provided. There are a number of cabinets for moving-coil loud speakers and radio-gramophones, and a new American type cabinet for panels of 18in. × 7in. at 18s.

Carrington Mfg. Co., Ltd., Camco Works, Sanderstead Road, Croydon.

Camco carrier cabinet for home-constructors.

CATESBYS. (3 & 4)

Among a number of receivers the four-valve screen-grid portable merits attention. Built into a suit-case covered with a material of blue waterproof with crocodile finish, this set is marketed at 16 guineas complete; it is extremely light, weighing only 25 lb. Particular attention has been paid to the screening of the H.F. valve, the general circuit and layout of which conforms to the latest accepted practice. The four-valve pedestal receiver containing a screen-grid H.F. valve is of the self-contained type but designed to work with an external aerial and earth. A cone speaker is built into the cabinet, and a hinged door at the back gives access to batteries and valves or to the eliminator if mains are available. The price is 14 guineas

Catesbys, Ltd., Tottenham Court Road, W.1.

Catesbys' super screened-grid suit-case receiver.

CELESTION. (180 & 183)

The enviable reputation gained by this firm is well maintained in this season's range of loud speakers. The "C" series have been reduced in price. The following prices are current for speakers housed in oak cabinets: C.10, £3 15s.; C.12, £5 12s. 6d.; C.14, £11; C.24, £20.

The Celestion Woodroffe pick-up, well known to readers, is still being marketed at £4 4s.

The new "Z" loud speakers retain the reinforced diaphragm, but have a new electro-magnetic movement which, it is claimed, gives an even wider frequency response than former models. The two speakers of this class are designated "Z.20" and "Z.25"; the first-mentioned has a resistance of 750 ohms, the size of the cabinet is 19½in. × 18½in. × 8½in., and the price in oak £7 15s. The more ambitious model has the same resistance, but

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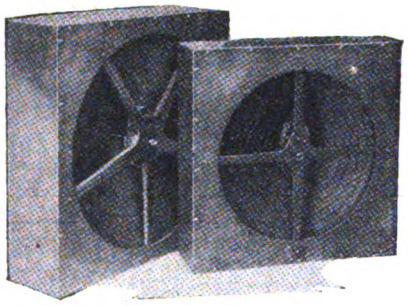
Stand-to-Stand Report.—measures 24in. × 24in. × 14in., and is priced at £15.

A new "Celestroda" moving coil speaker has been introduced for this season. Its acoustic output is adequate for talking film work, but with a modest input a highly satisfactory performance can

The new Celestion Z.20 loud speaker.

be had for home use. Housed in an oak cabinet with a field wound for a 6-volt D.C. supply and a speech coil connected to a transformer and filter, there is a model at £24.

For A.C. mains there is a speaker complete with mains transformer, rectifier, speech transformer, and filter for £25 10s., whilst for D.C. mains the price is £24 12s. 6d. The speech coil in each case is centred by three flexible metal strips,



Celestion shell case speakers for home constructors.

which allow axial, but no lateral movement. Home constructors who require speakers to fit into existing cabinets can now obtain shell case speakers fitted into plain stained boxes. The Z.10b model, with a 10in. diaphragm, costs £3 5s., while a variety with a 14in. diaphragm (Z.14b) costs £5 17s. 6d. This type has front adjustment, and the models designated C.10, C.12, C.14, "Shell," have back adjustment.

Celestion, Ltd., London Road, Kingston-on-Thames.

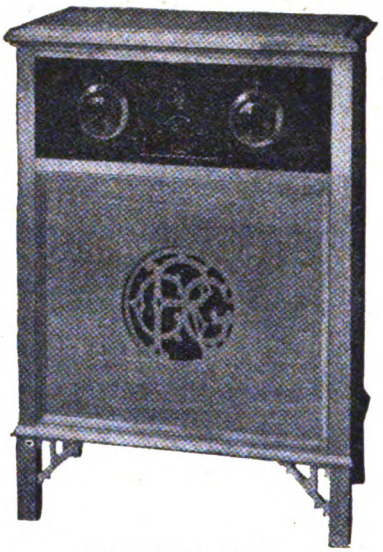
CITY & GENERAL RADIO CO. (256)

One of the most ambitious pieces of apparatus produced by this firm is an all-electric Cinema Amplifier. This is an electric gramophone, fitted with two turntables and fading device. The turntables are electrically driven.

An all-mains radio gramophone is also manufactured, both in A.C. and D.C. models. This instrument is also fitted with an electric motor.

Among other sets there is a three-valve H.F.-det.-L.F. mains set, and a receiver on "kit set" lines, stated to include all the best features of the most popular receivers, which sells at 9 guineas, complete with valves and royalty. Components of the highest grade are used.

An attractive pedestal cabinet, with space for a loud speaker and batteries, and priced at £2 10s., is also exhibited. It should be suitable for accommodating any conventional three-valve set of average dimensions.



City pedestal cabinet.

This firm are retail agents for wireless apparatus of every kind.

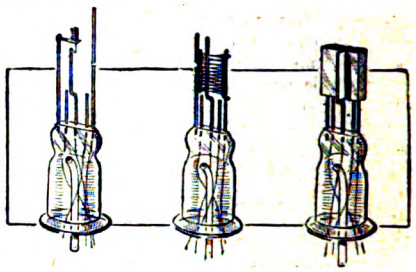
City and General Radio Co., Ltd., 46, *Watling Street, London, E.C.*4.

City Super Three.

CLEARTRON. (22)

Thoriated filaments with a fairly high current consumption have been replaced throughout by the more modern and economical coated filament in all types of valves produced by this firm, with the result that the great majority consume only 0.1 amp. Exceptions are the super-power varieties, but in no case does rated filament current exceed 0.25 amp. The construction and method of assembly of the electrodes have similarly undergone modification and all the valves are enclosed in pipeless bulbs. Leading-out wires from the electrodes are connected to the pins without soldering.

The 610 L.F. should be a particularly useful valve, with an impedance of 8,000 ohms and an amplification factor of 14—characteristics that should make it suitable even for the difficult task of bottom



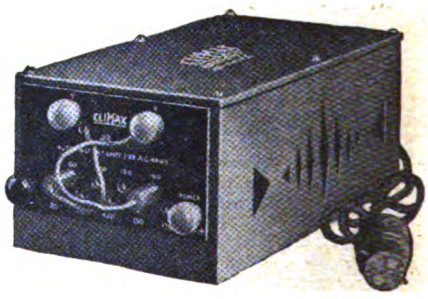
Electrode assembly of new Cleartron valves.

bend rectification preceding transformer coupling. This valve has counterparts in the two- and four-volt ranges, although, as is natural, their "figures of merit" show a slight falling off. The 210 H.F., with a two-volt filament and impedance and voltage factor of, respectively, 20,000 ohms and 18, would appear to be a useful valve for grid circuit detection or neutralised H.F. amplification. Power and super-power valves are available in all filament ratings at the price of 6s. 6d.; the ordinary types cost 5s.

Cleartron (1927), *Ltd.*, 21, *Cumberland Street, Birmingham.*

CLIMAX. (91 & 92)

D.C. and A.C. battery eliminators of entirely new design are the principal items of interest among this season's



Climax A.C. mains unit.

Climax products. Constant output is obtained on the intermediate voltages by means of a potential divider, which is an entirely satisfactory method when combined with resistances to prevent interstage coupling. H.F. and L.F. chokes, wire-wound resistances, and potential dividers are the principal Climax components.

*Climax Radio Electric, Ltd., Haverstock Works, Parkhill Road, Hampstead, London, N.W.*3.

CLIX (LECTROLINX). (261)

Under the name "Clix" we find at this stand every variety of connector, many types having been specially designed to suit exacting requirements.

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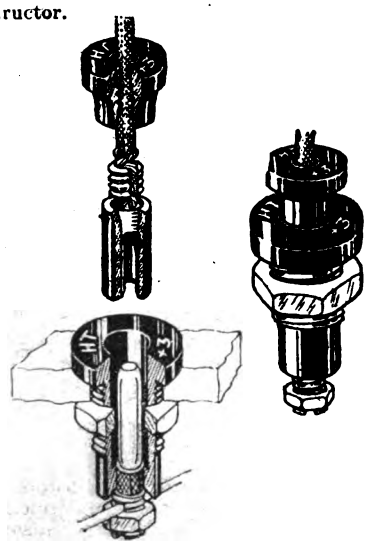
Stand-to-Stand Report.—

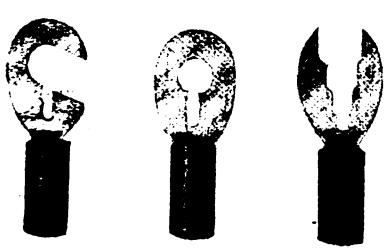
Of particular interest at the present time, by way of its suitability for mains-operated sets, is the new "All-in" plug and socket. Its principal merits include the complete insulation of all conducting parts, so that it can, in fact, be mounted in a metal panel. Both panel and connector portions carry indicating markings. Its flexible lead is easily terminated, and the plug and socket connector are of a reliable type. No metal parts are exposed when the plug is withdrawn. A wide variety of spade and plug connectors to be found at this stand are of interest to the set user as well as the set constructor.



Clix sockets in which no metal parts are exposed.

A new product is a low-loss valve holder in which the spring connections are mounted round a hollow bakelite shell. An interesting spring-jawed connector is used which will make reliable contact in spite of variation in valve pin spacing. Each of the four connectors is a single piece right to the point of connecting the lead.

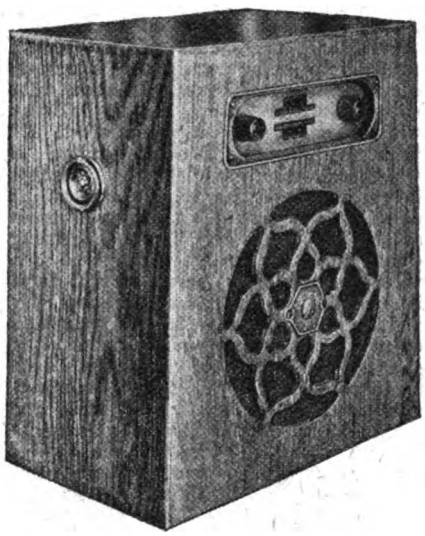
Lectrolinx, Ltd., 253, *Vauxhall Bridge Road, London, S.W.*1.



Specimen Clix battery connectors. (Lectrolinx.)

COLUMBIA. (94 & 96)

The radio products of this well-known gramophone company are entirely new, and the designs adopted clearly indicate the trend in modern commercial practice. Both as to circuit principle and external finish the two models shown depart in many details from the majority of sets. For instance, the Columbia Radio Table



Columbia table model type, 304.

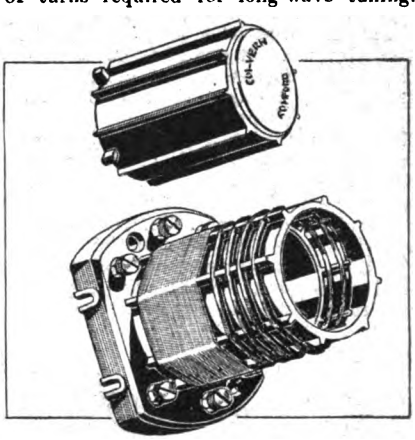
Model No. 304 incorporates three screen-grid stages, and by this means adequate selectivity is combined with a high degree of amplification. The problems of distortion by side-band cut-off can, of course, receive careful consideration when designing a selective three H.F. stage amplifier. Following such generous amplification, it is possible to fully load an anode bend detector even with distant station transmissions. Resistance coupling is adopted between detector and output valve. It should be mentioned that this entirely self-contained receiver is supplied for either D.C. or A.C. mains operation, so that the super-power output valve can be readily supplied with the high anode voltage of 200. The set is designed for use with an elevated aerial, but it is obvious that with such a high degree of H.F. amplification and the consequent extreme sensitivity obtained that good reception will be obtained without the aid of an aerial. For indoor use a wire 10ft. to 20ft. in length is suggested. Tuning is virtually by single knob control, though a fine adjustment is provided for critically adjusting the set to bring up a weak transmission. The wavelength ranges covered are 230-550 metres and 1,000-2,000 metres. An important feature is the calibration of the tuning drum in actual wavelengths, and provision is made for marking the settings of stations received. The A.C. model makes use of the Westinghouse rectifier. In either mahogany or walnut finish this self-contained set is priced at £33.

Included in the range of new Columbia sets is a five-valve portable. An important feature of this receiver is the readiness with which it can be adapted for mains operation. No alteration to the set is necessary, the batteries being left in position in the receiver. The same valves are used for both battery or mains drive, whether D.C. or A.C. Five triode valves are used, arranged as two H.F. and two L.F. stages. Separate frame aerials are employed for long- and short-wave bands. Tuning is by horizontal thumb-operated controls. Reaction is only associated with the first valve, and therefore has the effect of sharpening the tuning without affecting the aperiodic circuits which follow. Leaky grid detection is adopted owing to its great sensitiveness to a weak signal, while the L.F. stages are transformer coupled. A generous power valve is used for the output. It is stated that the loud speaker has been specially designed to suit the conditions of the output circuit. The valve platform is strip connected, thus largely obviating the use of soldered connections, which experience has shown to often be the cause of failure in portable sets. In polished oak cabinet with all accessories and turntable the price is £17 17s. D.C. and A.C. battery power units for use with this set are available at £10 10s.

Columbia Graphophone Co., Ltd., 92, *Clerkenwell Road, London, E.C.*1.

COLVERN. (98)

"Colvern Coils for Every Modern Radio Circuit," is a claim that is well substantiated by the wide variety of tuning inductances exhibited at this stand. Set constructors for the past three or four years have utilised Colvern interchangeable formers in the making up of coils to suit their special requirements, and as a result there are so many varieties that it is impossible to enumerate them here. The basis of all Colvern coils is a light and well finished bakelite former, ribbed in the case of broadcast band coils and slotted to accommodate the large number of turns required for long-wave tuning.



The new Colvern two-range coil. It can be fitted with either a rotatable reaction coupling or a fixed internal primary winding.

Mention need only be made here of the new products. The home constructor will find a new form of tuning coil, by the use of which set construction becomes much simplified. On a single compact former are both long- and short-wave windings, the long-wave coil being section wound and arranged at a suitable distance from the broadcast band coil so that it may be short-circuited. While

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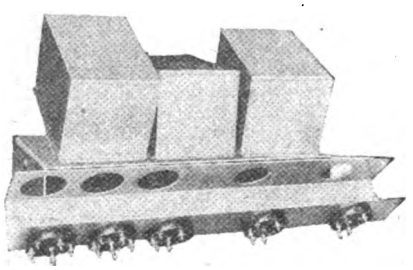
Stand-to-Stand Report.—

like their predecessors these coils may carry a primary or reaction winding, it is to be noted that a rotor has now been introduced within the coil former to permit of a variable coupling. Such an arrangement possesses many advantages.



Colvern screening equipment.

Used as a variable aerial coupling a control of selectivity is readily provided, and in this respect this new rotor carrying coil is particularly suited to the requirements of London listeners, who may now need an adjustment to regulate selectivity. Another application is that of variable reaction coupling, and no longer is it necessary, as with a fixed reaction winding to experimentally adjust the reaction turns in order to produce a smooth reaction control. The rotor is a thin bakelite former, ribbed and slotted, and is carried between a pair of spring contacts. Provision is made for adjusting the position of the coil within the former so that it may couple to the best advantage with the long- and short-wave circuits. This new coil and rotor will find many applications in radio receiver design and sells at 8s. 6d. Another component of particular interest is a dual-range H.F. transformer, specially suited as an H.F. intervalve coupling for the screened valve. It embodies an inset to the standard former so that the primary winding is tightly coupled to the secondary. The price is 12s. 6d.

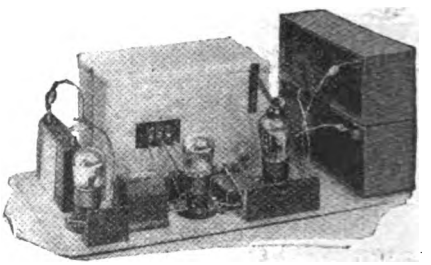
Colvern receiving sets are displayed for the first time, and herein is the evidence of an extension of activities from component to set manufacture built upon a foundation of a competitive interest in amateur set construction. Consequently, many refinements are to be found in the sets. The "Sirius Alpha" is a four-valve mains-operated receiver embodying two screen-grid H.F. stages, indirectly heated detector, followed by power-pentode output. The eliminator is incorporated and makes use of a valve rectifier with full-wave rectification. Assembly is carried out on an all-metal chassis and the stages are completely screened by being totally and separately enclosed in metal boxes. In order that adequate power output can be obtained without overloading a potential of 300 volts is adopted. Volume control is associated with the aerial circuit, so that in cutting down the volume overloading of all valves throughout the receiver is at the same time avoided. As a strong signal is usually an interfering one, the volume control is so arranged that as it is brought into operation the selectivity is improved. This set is one-dial-operated, the several tuned circuits being ganged by means of horizontal dials arranged beneath the tuning compartments. It is interesting to note the thoroughness of the screening, even to that of separating the various valves.

Special screening compartments that have been developed in the construction of the "Sirius" sets are also shown separately. These have been slightly modified to render them suitable for the requirements of the home constructor.

Colvern, Ltd., Mawneys Road, Romford, Essex

COSSOR. (78, 138, 173, & 174)

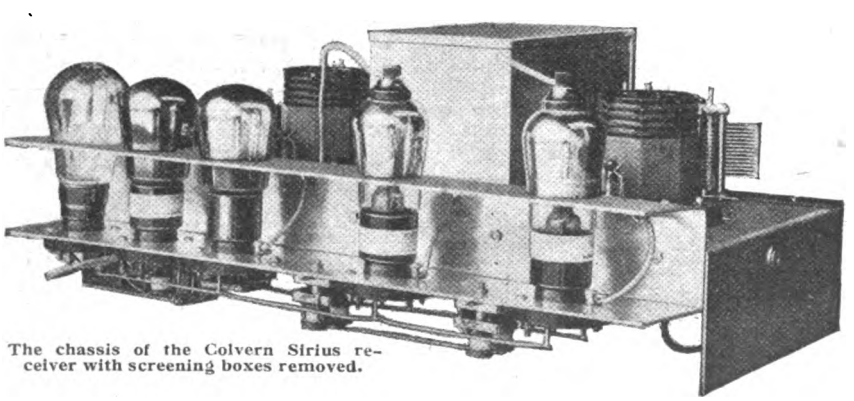
The vague description "easy-to-build" is capable of latitude in its interpretation. This observation, however, can be no more truly applied than it is to the new Cossor Melody Maker. Experience is not required in the assembling of components, but it is in the wiring up of a receiver that not only is much work involved, but in addition to the danger of a faulty connection the actual arrangement of the wiring may seriously impair the performance. Particularly is this comment true as regards H.F. equipment, and it is for this reason that an entirely new method of set construction is to be found in this season's Cossor set. Here the entire H.F. equipment is built as a unit, and thus the difficult wiring associated with a tuned aerial and H.F. intervalve coupling is avoided. The tuning condensers are ganged so as to give true one-dial control. This H.F. unit is of convenient and compact dimensions, and it is to be noted that the screening is rendered particularly effective by tightly bonding the joints with rivets, while complete screening is provided between the tuned aerial and H.F. circuits. Every detail appears to have been carefully planned, the number of components having been reduced to only ten, which when assembled on the oak-faced ply baseboard are connected together with twenty wires. There are no soldered connections. The simple layout adopted produces a chassis form of construction so that the entire equipment may be placed into an attractive metal cabinet on the front of which is an escutcheon plate exposing the three controls and the tuning scale. A point of detail, but one of importance when good finish is the aim, is the entire avoidance of exposed screw-heads. Even the grub screws on the controls are not to be seen. Another detail is the avoidance of terminals, while unsightly battery leads are avoided by giving space to the H.T. battery within the metal cabinet. All components have been specially constructed even to the plug connectors. The price of the complete kit including the latest type Cossor valves together with the handsome cabinet finished in blue lacquer and with oxidised silver escutcheon is £8 15s. An A.C. mains model built on similar lines is also available, and costs £15.



1930 Cossor Melody Maker. The H.F. and tuning components are supplied as an assembled unit.

A complete two-valve all-mains set is also shown. It is specially suited to the conditions which will exist when the new B.B.C. Regional Scheme comes into operation. The price is £10 10s. This two-valve receiver is also available associated with the loud speaker, the operating panel being exposed beneath a hinged cover lid. The external appearance is thus that of an attractive loud speaker requiring no external or additional accessories. It is a well-finished equipment, and is priced £14 14s.

Cossor valves are too well known to require detailed comment here. The range includes no fewer than thirty-five types, and is made up of indirectly and battery-heated valves, and includes pentodes. In each of the 2-, 4- and 6-volt classes there are six types, the S.G., R.C., H.F., L.F., P., and X.P. The filament current is in most cases 0.1 ampere, but is necessarily increased to 0.2 and 0.3 ampere in respect of certain of the lower voltage valves of the P. and X.P. types. All Cossor S.G. valves have an amplification factor of 200



The chassis of the Colvern Sirius receiver with screening boxes removed.

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Stand-to-Stand Report.—with an A.C. resistance of 200,000, and should therefore give a single stage amplification of over 70 when used with a stable H.F. intervalve coupling. The indirectly heated screen-grid valve

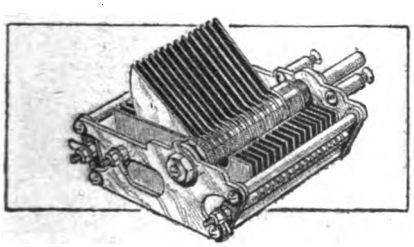
A new departure in self-contained set design—the Cossor two-valve mains receiver.

M.S.G.41 is capable of giving an H.F. stage gain of probably double this figure.

A. C. Cossor, Ltd., Cossor House, Highbury Grove, London, N.5.

CYLDON (SYDNEY S. BIRD & SONS). (156)

In view of the ease with which H.F. amplification may be obtained by the use of a screen-grid valve there is an increase in the building of sets embodying tuned H.F. stages. If bulky construction is to be avoided it is essential that as little space as possible shall be taken up by the tuning condenser. Appreciating this requirement Sydney S. Bird and Sons have introduced a new model, the "Cyldon Junilog." The overall dimensions and the sweep of this type of condenser are particularly small, the length being 2⅜in., and the width with vanes fully extended only 3½in. This compactness has compelled a departure from the usual



Cyldon Junilog condenser.

three-hole fixing of Cyldon condensers, but when required three-hole fixing bushes and screws can be supplied. The 0.0005 mfd. "Junilog" condenser is priced at 8s. 9d.

This same type of condenser is being incorporated in a new type of twin condenser, and in this respect its small diameter plates are particularly suited to the requirements of ganging as compared with plates of generous sweep where a slight displacement would considerably alter capacity. Overall dimensions have been cut down to a minimum. The price of this twin model, the Junior "Synchratune," is 30s., complete with bakelite drum dials, fixing screws and escutcheon plate.

Sydney S. Bird and Sons, Ltd., "Cyldon" Works, Sarnesfield Road, Enfield Town, Middlesex.

DANIPAD. (219)

Besides a full range of cut ebonite panels with various surfaces, there is exhibited ebonite tubing, ribbed low-loss formers, rod and wedge rod in many varieties. Complete coils for popular Kit sets are manufactured, as well as H.F. chokes, ultra short-wave inductances, and dual-range coils with base switching. There are coil holders, neutralising condensers, wavetraps and switches, and bakelised formers up to 7in. in diameter. There are, in fact, very few wireless components required by the amateur that are not stocked by this company.

Danipad Rubber Co., Ltd., 5 and 7, Market Street, Finsbury, E.C.2.

DAVENSET (PARTRIDGE, WILSON & CO.). (235)

This firm are manufacturers of several different types of battery chargers, intended mainly for the use of wireless dealers, garages, etc.; H.T. and L.T. models are available, and gas-filled valves, giving full-wave rectification, are employed. These instruments are economical in first cost and upkeep.

A transportable receiver is also shown. This instrument is on fairly conventional lines, and includes Mullard "Permacore" transformers and a Celestion loud speaker. Differential control of reaction is embodied in its design.

There is also a "Conversion Kit," intended for use in converting existing battery sets for A.C. mains operation. It comprises a power transformer with an adjustable primary suitable for mains voltages between 200 and 250, and also centre-tapped L.T. windings giving, respectively, 4 and 5 volts. A smoothing choke is included in this "kit."

The "Grippleshell" adjustable bracket, manufactured by this firm, is now supplied in several types. This useful fitment is designed to act as an aerial wire guide in positions where it would otherwise be difficult—or even impossible—to avoid earthing the wire to the eaves, corners, chimneys, or other parts of a building. It carries a heavy porcelain shell insulator at one end.

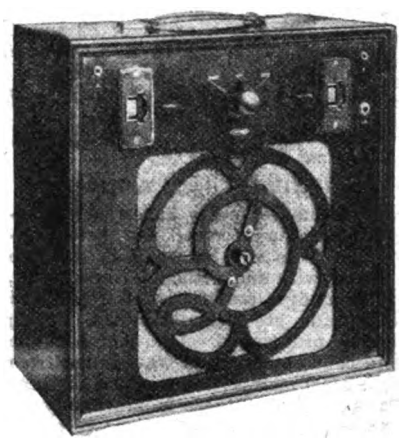
Partridge, Wilson and Co., Loughborough Road, Leicester.

DAY. (7)

For the dance hall, restaurant, or cinema, a powerful sound-reproducing instrument is being exhibited which is provided with three turntables and gramophone pick-ups. To obtain special "effects" it is possible to superimpose the outputs of two or three records, and this is aided by differential volume control. The gramophone motors are electrically driven, and all high and low tension current is derived from a motor generator housed in the base. As an emergency supply in the event of the failure of the mains, a set of H.T. accumulators is available. Assuming a B.O.T. power unit at 2d., the total running cost per hour is under 1d., and it is claimed that the gramophone pick-up causes so little wear that records running for several hours a day last for six months. There is a "Musikon" moving-coil loud speaker.

This company also factors the better-known radio components on the market.

Will Day, Ltd., 19, Lisle Street, W.C.2.



Davenset transportable.

DE LA RUE. (260)

Manufacturers of mouldings and moulded materials for radio purposes.

Thos. De La Rue and Co., Ltd., 90, Shernhall Street, Walthamstow, London, E.17.

DEW. (26-28)

The apparatus shown is described as "a complete show in miniature," and represents a selected range of sets, components and accessories of particular interest to the radio dealer.

A. J. Dew and Co., 33-34, Rathbone Place, London, W.1.

DIBBEN. (15 & 65)

The chief products of this company are receivers and loud speakers. The Monarch-Three type S.G.T. set contains the well-tried combination of screen-grid valve followed by a leaky grid detector and power valve; the price is 7 guineas (royalties extra).

A similar receiver, but incorporating A.C. equipment for all-mains drive, is marketed at 16 guineas (excluding royal-

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Stand-to-Stand Report.—

ties). The Monarch-Three type T.S. contains a detector and two L.F. valves and an enclosed Amplion loud speaker; it is retailed at 7 guineas (excluding royalties). Another receiver, having a similar layout but housed in rather a larger and more elaborate cabinet in Jacobean style, includes a large balanced-armature speaker, and is capable of delivering a generous undistorted output.

There are several loud speakers contained in attractive cabinets. The Monarch-Boudoir speaker, for instance, embodying a two-pole unit, sells at 2 guineas, and a rather larger speaker with balanced armature movement recommended for large rooms or dance halls is priced at 6 guineas; this is called the "Cromwell Royal" model.

Wm. Dibben and Sons, Ltd., 80, *St. Mary's Road, Southampton.*

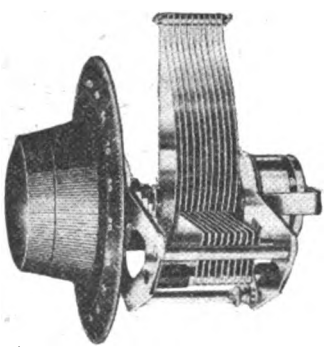
DONOTONE. (268 & 269)

The Super-Donotone loud speaker, which is the chief exhibit this year, is housed within a circular cabinet having a drum 18in. in diameter and a depth of 12in. There is a series of 32 tuned gongs, each responding to its own note and a diaphragm of special composition. The price, in mahogany or oak, is 10 guineas.

The Donotone (Regd.) Loud Speaker, 40, Furnival Street, E.C.4.

DUBILIER. (181 & 182)

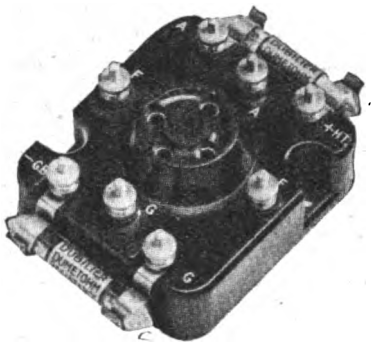
Condensers for every conceivable position in a radio receiver are being exhibited. The well-known K.C. variable condenser with and without drum control, and the midget condensers of 0.0001 and 0.0002 mfd. are being retained. This season's programme also contains the toroid coils embracing a wave-range from 22½ to 2,000 metres; the winding of these coils is such that there is practically no external field, with the obvious corollary that there is an absence of unwanted direct pick-up from a nearby powerful transmission.



Dubilier K–C condenser.

The R.C. coupling unit combined with valve-holder is useful where economy of space in a receiver calls for consideration. Complete with two Dumetohm resistances the price is 7s. A point worth noting is that the valve-holder may be used for the valve which precedes or follows the resistance stage in the unit. There are four high-frequency chokes; the first choke of this series is primarily intended to be connected in the anode circuit of the detector valve where its function is to prevent the passage of radio-frequency currents into the L.F. amplifier. It should not be used on wavelengths below 100 metres. Type 40 has a higher inductance and will, therefore, act as a more efficient impedance at the higher wavelengths. Type A.C. is specially designed for aperiodic coupling in H.F. amplifiers. There is also a short-wave choke known as type S.W.

For low-tension eliminators there is a series of dry electrolytic condensers, and for H.T. eliminators the tapped condenser block, many examples of which are made by this company, is likely to be more widely adopted in view of the advantages it confers with regard to cheapness, simplicity in wiring, and compactness.



Complete R.C.C. stage—a Dubilier product.

Paper-dielectric condensers of 2 mfd. capacity, with wider and wider application as all-mains sets become more extensively used, are available tested at 2,500 volts D.C. downwards. The price of the model tested at 400 volts D.C., for instance, is 3s. 6d. This condenser has a working voltage of 200. The low power factor of mica-dielectric condensers for decoupling in screen-grid circuits is becoming appreciated by amateurs. Condensers of this type, with capacity values of 0.01 mfd. to 0.05 mfd., marketed from 4s. to 5s. 6d., should therefore be of interest.

A range of dry batteries is included for this season; these are made in single and treble capacities. The smaller 99-volt battery with grid bias tappings sells at 11s. 9d., while the 100-volt battery of the heavy-duty type is priced at 22s.

Besides the Westminster portable radio-gramophone which is now well known there is a new all-electric 3-valve screen-grid receiver available for D.C. or A.C. selling at £25. Both aerial and H.F. inductances are separately tuned. The reaction control is ingenious, as it automatically changes the reaction coupling for long and medium waves.

A D.C. eliminator made to the specification of *The Wireless World* "Hum-Proof D.C. Eliminator" is on this stand.

Dubilier Condenser Co. (1925), *Ltd., Ducon Works, Victoria Road, North Acton, W.3.*

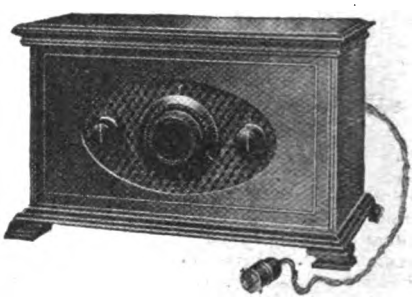
DULCETTO-POLYPHON. (278)

Manufacturers and factors of gramophones, records and accessories as well as radio apparatus.

Dulcetto-Polyphon, Ltd., 2 and 3, Newman Street, Oxford Street, London, W.1.

DUNHAM. (47 & 48)

Battery- and mains-fed receivers are the chief exhibits of this company. The



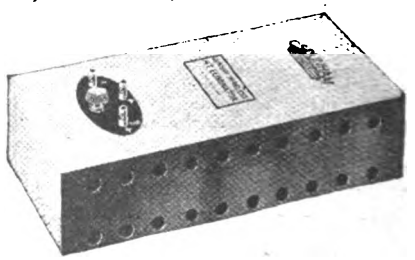
The Dunham "Simplicity-Two" Receiver.

"Simplicity-Two" set is housed in an attractive cabinet with an oval panel on which the tuning dial and capacity control of reaction is arranged. Wave-range switching is provided. Complete with valves and royalties the price is £6 10s. This set, adapted for all-mains operation, sells at 13 guineas complete, while a three-valve model is marketed at 21 guineas. For those who wish to have these sets in more elaborate furniture there is a series of pedestal "Simplicity" receivers in which a Symphony cone loud speaker is fitted. Battery or eliminator compartments are provided, and the only external leads besides those connected to the mains, where these are available, are to the earth and aerial.

The Portable-Five, selling at 17 guineas, has two aperiodically coupled H.F. stages and the conventional regenerative leaky-grid detector. There is a balanced-armature cone speaker, and careful biasing of the valves results in a total anode consumption of only 8 mA. In the transportable set a point of interest is the provision of means whereby the accumulator can be charged *in situ* if supply mains are available. A home-charger containing a dry metal-oxide rectifier is being shown for 2-, 4-, or 6-volt accumulators. The price is 50s.

A frame-aerial supported on a ball-bearing turntable is a useful component for those desiring really good selectivity in the neighbourhood of a powerful station. The change-over from short to long waves is effected by a switch, and the price is 2 guineas.

C. S. Dunham, Elm Works, Elm Park, 131, Brixton Hill, S.W.



Dunham H.T. eliminator.

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Stand-to-Stand Report.—

D.X. COILS. (262)

H.F. chokes for both baseboard and clip-in mounting are shown. A new product is the D.X. Dual-Range Tuner using coils of the standard plug-in type. Short-wave coils, L.F. intervalve transformers, as well as a new "D.X." tone arm are included in the exhibits.

D.X. Coils, Ltd., 542, Kingsland Road, London, E.8.

EAGLE ENGINEERING CO. (77)

A new way of using the portable set is disclosed on this stand. The Eagle Engineering Co. has produced an upright cabinet with a spring motor-driven gramophone turntable, pick-up, and volume control. Space is provided to accommodate a standard "Warwick Portable Five" receiver in the front of the

Warwick radio gramophone.

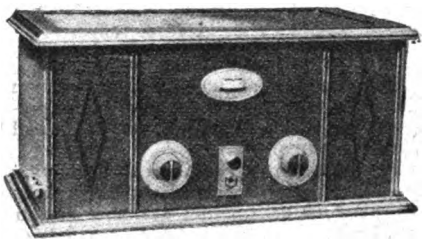
cabinet. The set, which is already fitted with a pick-up socket, can thus be used either for radio or gramophone reproduction in the home, or can be removed from the cabinet and taken out of doors at a moment's notice.

The "Warwick II" is a simple but apparently effective 2-valve det.-L.F. set sold at a low price. The front panel is attractively finished in imitation of oak by a new photographic process. Provision is made for using a pentode in the L.F. position when desired, and there is ample space in the cabinet for accommodation of the necessary batteries.

Apart from the Warwick Portable Five already mentioned, there is another neat five-valve portable of the suitcase type in which several interesting features are included. Controls are arranged inside the lid, which cannot be closed until the main switch is set at "off."

An inexpensive aerial tuner is also manufactured. This component has a rotatable reaction coil and a phosphor-bronze ball switch for changing inductance.

The Eagle Engineering Co., Ltd., Eagle Works, Warwick.



Warwick two-valve receiver.

EAST LONDON RUBBER CO. (274 & 275)

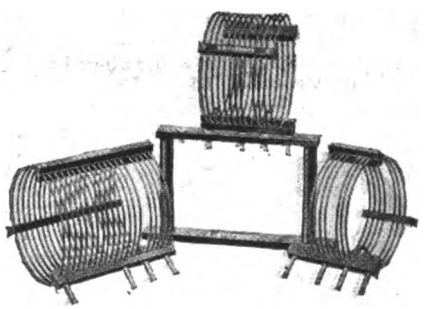
This company factors the more important wireless components and sets. A very comprehensive display of portable, transportable, and all-mains receivers is to be seen on their stand. When a visit is made to a factor's stand this year the preponderance of batteryless receivers is most marked, and is a sign of the changing times.

East London Rubber Co., Great Eastern Street, E.C.2.

EDDYSTONE (STRATTON & CO.). (109)

The three-valve short-wave home constructors' set is produced this year in improved form. It comprises a screen-grid H.F. valve with choke input from the aerial, a grid detector with reaction, and a single L.F. stage.

A new complete four-valve short-wave set has been introduced. It is similar to the three-valve arrangement, but has two L.F. stages (choke- and transformer-coupled). It is interesting to note that a parallel vernier condenser is connected across the tuning condenser, thus reverting to a practice applied to broadcast sets several years ago. It is stated that this has proved itself to be more satisfactory than the use of a tuning condenser with a very high reduction gear ratio. Complete decoupling is included in this set, which,



Eddystone short-wave coils.

by the way, has provision for a pick-up, and so should be particularly attractive for overseas users, for whom, indeed, it is largely intended. A special export model is supplied in a teak case. Special care has been taken to render the set suitable for use in tropical climates.

A new three-valve short-wave set in a crackle-finished metal case has just been introduced.

There is also a range of inductances for small-power transmitters, and a useful astatic short-wave choke.

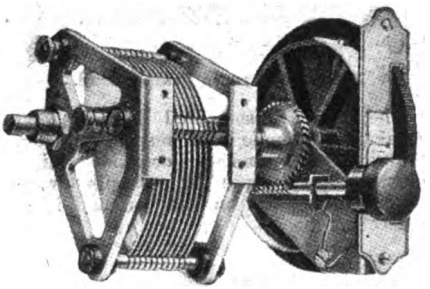
It should be noted that sets of coils for broadcast reception can be supplied with the Eddystone sets.

Kits of parts for the construction of double circular stretched-diaphragm loud speakers are also exhibited; two sizes are available. The kits include plywood frames, cloth, rubber beading, varnish, and full instructions. The completed instrument is suitable for operation with an Ormond or Blue Spot unit.

Stratton and Co., Ltd., Balmoral Works, Bromsgrove Street, Birmingham.

EDISON BELL. (116)

In view of the wide experience of its manufacturers, the Edison Bell all-mains radio-gramophone is certain to be examined with considerable interest. Its five valves are arranged as H.F. amplifier, detector, and two stages of L.F. magnification, with parallel valves in the output position. An external aerial and earth are used, and there are two tuning controls, operated by edgewise dials. Models for A.C. and D.C. mains are available.



Edison Bell drum dial condenser.

Volume control is effected by a potentiometer device whereby the output from the detector to the L.F. amplifier may be critically regulated. There is also an extra resistance control across the pick-up; this is, of course, inoperative when receiving radio signals.

The loud speaker is of the moving coil type, and special claims are made as to its sensitivity; it is connected to the output end of the set through a transformer.

An electric turntable motor is included, and there is also a scratch filter circuit. A battery model radio gramophone is also manufactured; its circuit arrangement comprises an S.G. high-frequency amplifier, detector, and pentode output valve. There are two tuning controls with reaction, and the frame aerial, built into the back of the cabinet, can be rotated through a knob protruding through the top panel. Provision is made for using the gramophone with an ordinary sound-box and built-in horn, should the batteries fail.

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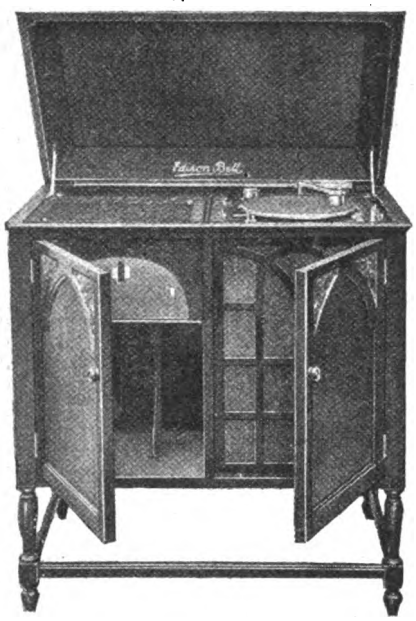
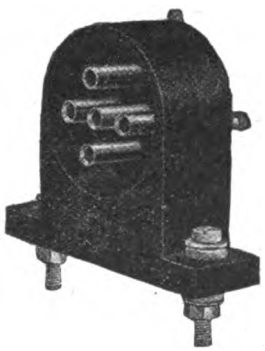
Stand-to-Stand Report.—

Another set, of a type which should become popular, is the "Maison Screened Grid Three." The feature of this set is a built-in frame aerial, although external aerial and earth connections can be added if desired. As the set includes a loud speaker and space for batteries, it is entirely self-contained.



Edison Bell radio gramophone.

The new Edison Bell Plaque loud speaker is intended for suspension from the picture rail, and thus occupies a minimum of useful space; it is supplied with an oxydised chain and hanger, and is of the cone type.



Edison Bell valve-holder.

New components include a variable resistance of the graphite track type, with a maximum value of 0.5 megohm. Contact is made with the track through a German silver ball. In the design of the new loud speaker drive unit especial pains have been taken to devise a reed movement free from undesirable resonances; the unit is intended to operate with a cone diaphragm. There are also new thumb-control condensers with knob vernier, reaction condensers, and useful valve-holders (suitable for the new valves) which have rubber shock-absorbing insulation.

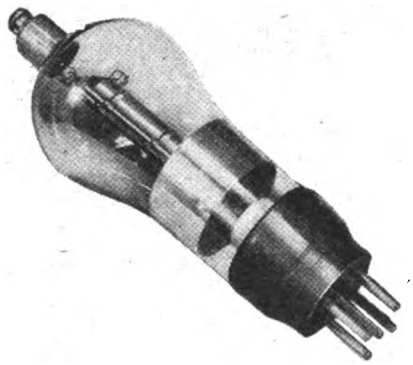
Edison Bell, Ltd., Edison Bell Works, Glengall Road, London, S.E.

EDISWAN. (148 & 153)

(Incorporating Metro-Vick Supplies & British Thomson-Houston Co., Ltd.)

Under a new arrangement, the Edison Swan Co. are marketing the radio products of the Metro-Vick supplies and B.T.-H. companies.

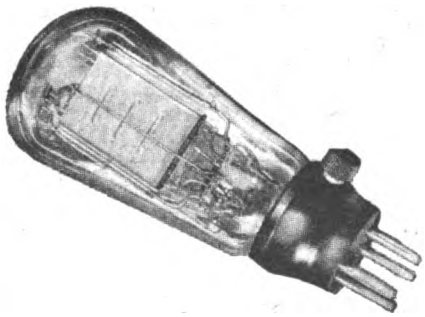
The well-known Cosmos valves, having the short-path characteristic, have been improved in design and are now known as Mazda valves. The large resources of the three companies have been pooled and the new complete range of 2-, 4-, and 6-volt valves is the product of their combined research and manufacturing experience. The Mazda series of valves also



The new improved Mazda AC/SG screened valve with 5-pin base having a central contact. (Ediswan.)

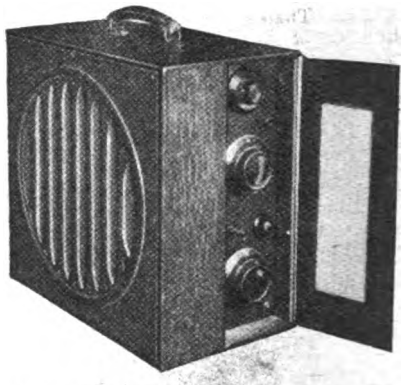
includes a number of the better-known B.T.-H. and Ediswan valves, having modified constants and new names. The most striking advance is probably in the 2-volt series, where mutual conductances up to nearly 4 mA./volt in battery-heated valves are obtained; such figures with filament consumptions well under one watt are remarkable, and, indeed, vie with the most efficient 6-volt valves, consuming greater filament currents.

The H.L.210, with an amplification factor of 26, and a mutual conductance of 1.25, will make a good neutralised H.F. amplifier, as well as an L-G detector. The P.240—a power valve—which will handle about 24 volts grid swing, has an A.C. resistance of 1,900 ohms. and an amplification factor of 7, giving a slope of



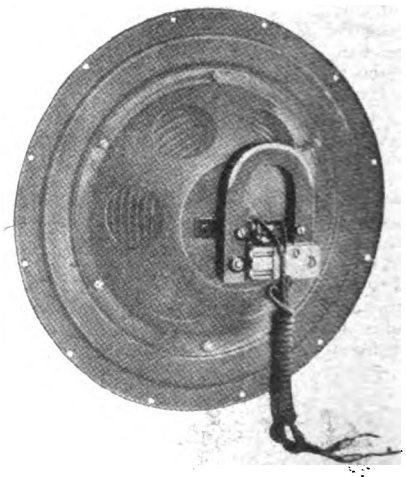
Mazda 230-Pentode valve (Ediswan).

3.7. There are two pentodes—the 230 Pen. and the 425 Pen.—having high mutual conductances and "earthed" grids connected to the control grids instead of the filaments to prevent the burning out of all the valves in a receiver, should the outer grid touch the plate



Ediswan transportable receiver for A.C. mains.

The battery-fed screened valve—the 215 S.G.—which has been fully described in the pages of this journal, has an A.C. resistance of 270,000 ohms and an amplification factor of 300, and the all-important anode-grid capacity is only 0.005 micro-mfd.—an extremely low figure allowing a theoretical stage amplification of no less than 150 to 160, with tuned anode coupling, without neutralisation, provided the



Ediswan reed-movement attached to cone assembly.

screening in the set is carried out with meticulous care.

The Mazda A.C./S.G. valve, an improved edition of the valve which is more familiar to our readers as the Cosmos A.C./S., has a five-pin base with a central contact, an amplification factor of 1,200, and a mutual conductance of 2. The duplex screening grid reduces the inter-electrode capacity to the very low figure of 0.0045 cms., so that the unneutralised tuned anode stage gain can be nearly 250 before instability begins to set in.

About a year ago the best screen-grid

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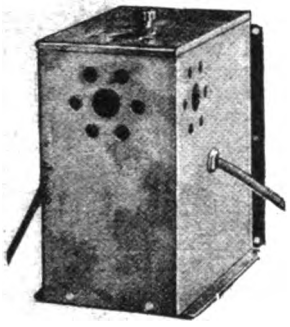
Stand-to-Stand Report.—valve available would only give a maximum stage amplification of about 60 unneutralised. The AC/HL and AC/P valves have indirectly heated cathodes and replaces our old friends, the AC/G and AC/R valves, whilst the AC/P1 is a super-power output valve capable of delivering 1,000 milliwatts undistorted A.C. output. There are four rectifying valves, three are of the half-wave type, and three have equipotential 4-volt cathodes, thus allowing interchangeability of the heater transformers.

To the flat-dweller, a batteryless, all-mains portable receiver will be of interest. Selling at 30 guineas, this set contains a balanced-armature cone loud speaker and four Mazda A.C. valves. The H.F. valve is an AC/SG, followed by two AC/HL valves and an AC/P. An enclosed eliminator supplies the H.T. and L.T. voltages and contains a UU60/250 full-wave rectifying valve. A small door at the side of the cabinet covers the control panel, on which there is provision for a gramophone pick-up and exterior aerial and earth.



The R–K rectifier unit for moving coil loud speakers (Ediswan).

In the new 3-valve all-electric A.C. and D.C. sets, selling at 20 guineas, there is a welcome departure from conventional layout; the controls are set on a sloping panel at an angle that makes for easy manipulation. The following valves are used: AC/SG, AC/HL, and 425-Pentode, and an elaborate screening scheme prevents unwanted interaction. Access can only be had to the various components after the mains supply is automatically cut off by an interlocking safety device. A variable loose-coupled aerial circuit not only assists in obtaining adequate selectivity, but also acts as a volume control.

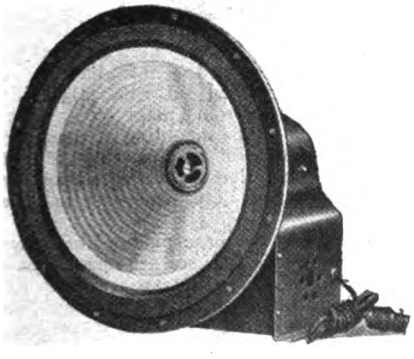
To match the pentode to different loud speakers, a variable choke-feed output is employed. The A.C. consumption is one unit of electricity for 35 hours' running.

In the D.C. model the loud speaker is isolated by two condensers, and the aerial is at earth potential as regards D.C., to prevent complications when the positive lead of the lighting supply is earthed.

There are also 3- and 4-valve battery receivers, in which the "elastic" aerial selectivity unit can be added if desired. A new Ediswan balanced-armature cone unit, having a particularly light armature, sells at 15s., and a reinforced corrugated cone assembly for mounting on a baffle-board is now on the market at 12s. 6d.

Added to the well-known range of B.T.-H. "R.K." moving-coil loud speakers, there is a senior self-contained unit with rectifier, thus providing its own source of field excitation. A separate rectifier unit for field excitation sells at £4 4s.; it is fitted with a transformer, smoothing condenser, and full-wave rectifying valve. A complete range of Metro-Vick eliminators is being shown.

Edison Swan Electric Co., Ltd., 1a, Newman Street, London, W.1.



Senior R–K loud speaker unit with field current rectifier included (marketed by Ediswan).

EELEX (J. J. EASTICK & SONS). (272 & 273)

Besides distributing the radio components of all well-known radio manufacturers, this firm makes a series of standardised plugs and sockets, and among other small metal parts, a treble-duty terminal. A vertical hole drilled in the terminal screw-head takes the standard Eelex T.14 plug or wander-plug. The under-surface of the terminal head when screwed down will hold a spade connection, whilst a horizontal hole through the centre of the terminal provides for the pin type of connector or the end of a wire. The threaded shank is slotted to take a sub-panel wire, thus dispensing with soldering. There are no fewer than 40 indicating tops to these terminals, which sell at 4½d. each.

For portable sets where the space is extremely limited the Eelex midget wander plug, having the very minimum of dimensions, should prove useful.

J. J. Eastick and Sons, 118, Bunhill Row, E.C.1.

EFESCAPHONE (FALK, STADELMANN & CO.). (278)

New screen-grid receivers for both battery and mains operation have been introduced since last year. The older models have been improved in details of construction and in the matter of appearance.

A portable suit-case type of set with tuned H.F. amplification (S.G. valve), detector, and two L.F. stages, has recently been produced. This is in addition to a more conventional five-valve self-contained set, with aperiodic H.F. amplification, which is shown in both suit-case and upright transportable form.

All the eliminators made by this firm have been brought up to date by the provision of means whereby screening grid voltage can be critically adjusted. In addition, a new mains unit, for use with indirectly heated valves, is exhibited. This instrument provides both anode current and low-tension A.C. for the heaters.

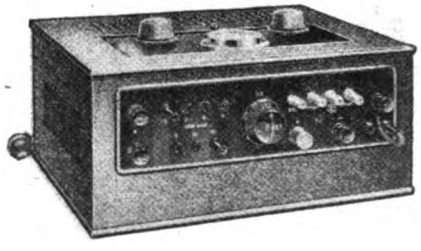
Falk Stadelmann portable.

Another new product is a cone loud speaker employing a novel method of construction, which is made in several types.

Falk, Stadelmann, and Co., Ltd., Efesca Electrical Works, 83 to 93, Farringdon Road, London, E.C.1.

EKCO (E. K. COLE). (8-11)

Battery eliminators as well as mains operated receivers are the specialised products of E. K. Cole, Ltd In considering the wide variety of apparatus displayed it is as well to adopt a useful classification introduced by the makers. Thus eliminators are divided into three classes, referred to respectively as the ten, twenty and sixty milliampere range. In each of the three classes there are several models giving various voltage outputs and embracing both A.C. and D.C. supply. It is explained that the various voltages obtained are produced by separate resistances as against the somewhat uncertain practice of using a common potential divider. All rectifiers are of the Westinghouse type excepting two auxiliary units which are intended for attaching to a D.C. eliminator, and in which case the rectifier is a Philips valve. Metal containers are used in every instance except-



Ekco H.T. and L.T. eliminator for use with D.C. supply.

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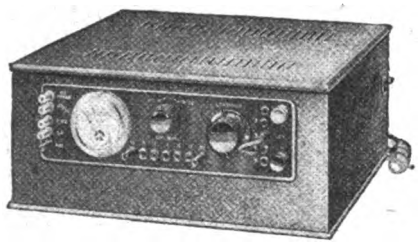
Stand-to-Stand Report.—
ing, of course, complete receiving sets, while precautions are taken in the arrangement of the terminals to render it impossible for the user to receive a shock. In the 10 mA. range is a D.C. eliminator, which at 17s. 6d. costs little more than the dry battery which it replaces. It has, however, only a single voltage tapping of 120. Two other models are included in the ten mA. range, and these are for use with A.C. and D.C. supply, and have two voltage outputs, estimated at 60 volts 20 mA. and 120 volts 10 mA.

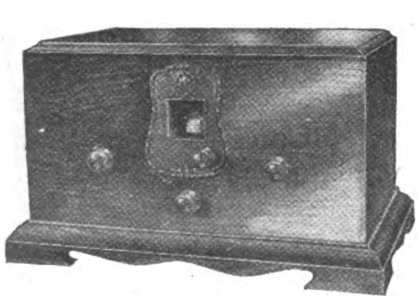
It is probable that the 20 mA. range includes eliminators more particularly meeting popular requirements. Both A.C. and D.C. models include three voltage outputs, for in addition to the 60- and 120-volt connectors there is a 60- to 80-volt potential arranged to suit the requirements of screen-grid valves. Advancing in the range but under the 20 mA. heading there are models in which the 60-volt output is replaced by a continuously variable potential of 0 to 120 with current output on this terminal up to 6 mA.



Ekco H.T. and L.T. eliminator for A.C. supply.

Five and six voltage outputs are provided in the A.C. and D.C. models of the 60 mA. series. To take a particular instrument, the A.C. model 5T.60 gives an S.G. voltage of 60 to 80, two independently variable outputs of 0 to 120, a fixed potential of 120 to 150 depending on the load taken, which may be up to 16 mA. and a power output up to 200 volts which falls to 150 when loaded to 50 mA. The price of this model is £10 10s., and a corresponding instrument for use with D.C. supply is £4 15s.

The problem of obtaining H.T., L.T. and grid bias from D.C. or A.C. mains has been undertaken, and four models are shown by the use of which a receiver becomes entirely mains operated. The D.C. model CI.A is a generous outfit provided with four H.T. potentials with an output up to 60 mA. and an L.T. supply up to 0.6 ampere, together with grid-biasing potentials up to 21 volts. It is emphasised that no alteration is necessary to the existing receiver. A corresponding A.C. model, it is interesting to note, is not designed on the assumption that special or indirectly heated valves are to be used in the receiving set. The L.T. output is 1 ampere, and it is stated that the use of this unit involves no more complication than the batteries which it replaces.



Ekco all-mains receiver. Type P.2.

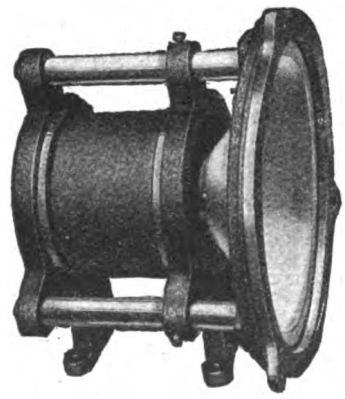
Mains-operated receiving sets are also to be seen. The designs are unique, and do not follow popular radio practice. A two-valve set, the P.2, meets the requirements of a large body of listeners by way of providing "trouble-free" reception from a local station. The output valve is a pentode, the P.M.24, while the D.C. model makes use of the P.M.4DX as a first stage valve, and in the A.C. model the valve is the A.C/G. It is stated that this receiver is specially selective, while the degree of selectivity can be varied in order to suit the set to local conditions. A three-valve model, the SGP3, is provided with a screen-grid H.F. stage as well as pentode output. Single-control tuning is arranged, and a compensating control enables maximum results to be obtained with aerials of different dimensions. The three-valve model for either A.C. or D.C. supply is priced at £21. Both the two- and three-valve models cover the wave ranges 2/500 metres and 1,000/2,000 metres.

E. K. Cole, Ltd., "Ekco" Works, London Road, Leigh-on-Sea, Essex.

ELLISON & HILLMAN. (29 & 30)

As wholesale stockists this firm displays a representative selection of the coming season's equipments.

Ellison and Hillman, 123-125, *Albion Street, Leeds.*



Epoch permanent magnet moving coil loud speaker.

EPOCH. (218)

Fourteen different types of moving coil loud speakers, together with many cabinet models, ranging in price from £2 10s. to £9 5s. are exhibited. Interest in the moving coil type of loud speaker still continues to gain ground, while its recent innovation in the cinema firmly establishes its superior merit. Cinema and public address types are included in the Epoch range, while for the more modest requirements of the home there is a permanent magnet model.

A.C. mains transformers and smoothing chokes are now produced in addition to loud speakers, while a scratch filter unit for use with a gramophone pick-up is a new component of interest.

Epoch Radio Manufacturing Co., Ltd., 3, Farringdon Avenue (near Ludgate Circus), London, E.C.4.

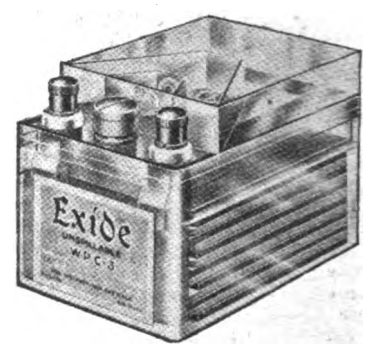
EVER READY. (139 & 142)

In addition to all types of batteries representative of the application of dry cells to radio purposes, we find both H.T. L.T. accumulators. Testing voltmeters suitable for the examination of H.T. and L.T. batteries are included.

Ever Ready Co. (G.B.), Ltd., Hercules Place, Holloway, London, N.7.

EXIDE. (172 & 175)

An entirely new H.T. battery, the Exide type WY10, is included among the wide variety of Exide products. This battery has been specially introduced for use with the generous amplifier,



Specimen Exide battery for use with portable sets.

such as the ambitious moving coil equipment, public address apparatus, and talking picture installation. The considerable thickness of the plates is a noteworthy feature, and it is obvious that the cells are intended to withstand hard usage. Non-interchangeable terminals are provided. The new terminal design is an interesting feature of this season's batteries, and while red and blue colourings are used the positives are in addition made octagonal and can therefore be readily distinguished in the dark. Another feature is the introduction of the ebonite moulded lid with all Exide cells, which are in glass containers. This permits of the moulding of the plate pillars into the lid so that they cannot possibly work loose, while absolutely eliminating acid creepage on to the terminals.

A speciality has been made of batteries for portable sets. There are many types, all fitted with an acid trap arrangement, rendering them proof against the spilling of acid even under the most severe conditions of shaking or tipping.

The DTG type cell is well known, though it is not always appreciated that this cell has been specially constructed

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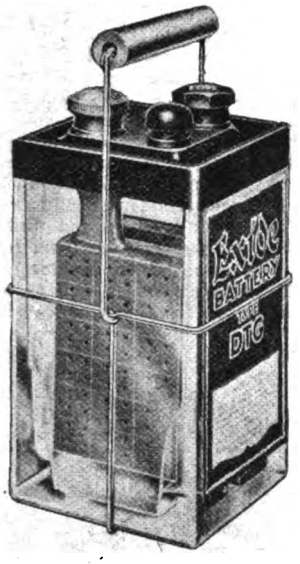
Stand-to-Stand Report.—

so as to withstand long periods on open circuit. This class of cell is referred to as the "Mass" type, and it is claimed that such cells can be left without attention for long periods and suffer no detri-

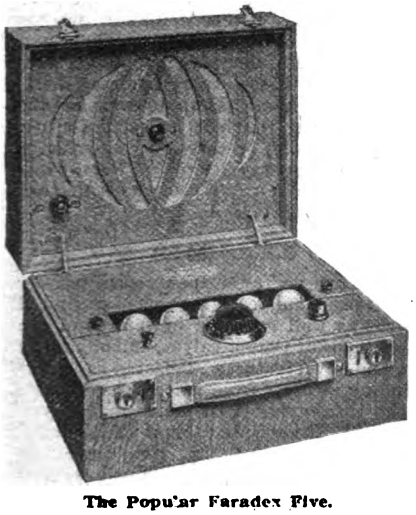


Exide "Mass" type cell. Dissimilar terminals form a new feature.

ment. The internal resistance is low and the voltage remains steady. Grid biasing batteries (types WJG and WHG) are also shown and consist of five small cells with two-volt tappings, and these also are designed to withstand long use on open circuit.

Included in the display is a selection of loose plates, separators, and other cell components illustrating the construction and technical details of the many and varied types of Exide cells to be found on the battery market.

The Chloride Electrical Storage Co., Ltd., 217-229, Shaftesbury Avenue, London, W.C.2.



The Popular Faradex Five.

FARADEX (ROOKE BROS.). (119)

Three types of Faradex portable receivers are shown. The Faradex Portable Five is a suitcase model, which in solid leather case of antique finish is priced at £16 16s. A distinctive feature is the provision for the use of a gramophone pick-up. A less expensive model, the Popular Five, is offered at the low price of £14 14s. There is a new four-valve portable in which the H.F. stage incorporates a screen-grid valve. This is a high-grade set, selling at £18 18s.

An interesting form of H.T. eliminator is shown, together with a wide range of Faradex components. The eliminator is unique, in that it employs a special form of chemical rectifier known as the Chromal.

Rooke Bros., Ltd., 55, Cardington Street, London, N.W.1.

FELLOWS. (32 & 33)

There are eight receivers in the programme for this season. The "Regal-Three" contains a Mullard screen-grid H.F. valve, followed by detector and pentode output, and sells at £21 10s., including high-tension battery, Exide two-volt 100-amp.-hour accumulator, and cone speaker.

The "Regal Four" employs anode bend detection, and has two L.F. valves, but does not include a pentode; the price is £24 15s.

There are four receivers in the "Little Giant" series, ranging in price from £11 5s. to £14, and a very complete equipment is included. There is also a new set entirely operated from A.C. mains.

A five-valve portable set listed at £15 in imitation leather, and £22 in real leather, is a newcomer this season, as is also a cabinet speaker claimed to respond to an exceptionally wide musical range.

Fellows Mfg. Co., Ltd., Cumberland Avenue, Park Royal, N.W.

FERRANTI. (74 & 76)

One cannot help feeling at times that the extreme care a manufacturer may have taken to make a particular component as perfect as possible may be of no avail when combined with another component of inferior performance. It is in this respect that one often views the adoption of specially designed intervalve couplings when the output stage and its associated loud speaker so often possess serious defects. Considerable importance attaches therefore to the introduction by Ferranti of a moving-coil loud speaker. Most of those technical points appreciated by the amateur are found to be present in this new instrument. A flux density of 11,000 lines per sq. cm. is obtained across the gap with a consumption of 23 watts in the field coil, and this, in turn, may be derived from an A.C. rectifier taking 35 watts from the mains. This high current consumption, which is insignificant when dealing with mains supply, is of first importance by way of producing the highest possible flux density. A valve rectifier, the U.8, is built into the mounting of the loud speaker so that it becomes an entirely self-contained unit. Supple centring is adopted with a large diameter coil, while a leather mounting, used because of its lasting properties, supports the cone.

Ferranti moving-coil loud speaker for use with A.C. supply.

Complete with rectifying equipment for use with A.C. supply, the loud speaker is priced at £10. The D.C. model, with similar external mounting, costs £6 10s.

Another new feature is the anode feed units, which form a compact combination of anode feed resistance and by-pass condenser. Their purpose is that of preventing interstage coupling as well as regulating the several anode voltages required in a receiver. It will be remembered that Ferranti were largely responsible for the introduction of the anode feed arrangement as a preventative of oscillation trouble, and in connection with the use of these new units a pamphlet has been produced showing typical circuit arrangements. A triple unit combining three resistances with three condensers is also produced, and when necessary this can be connected as a potentiometer, by which means a reduced potential will remain constant in spite of a change of current

The new Ferranti anode feed unit.

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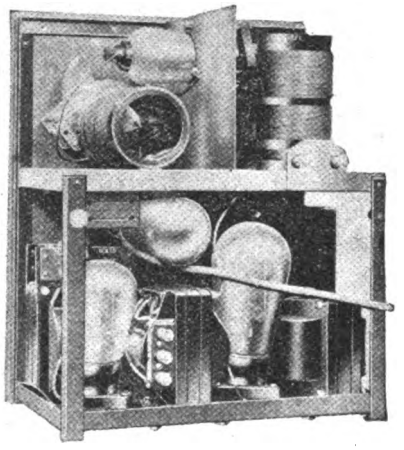
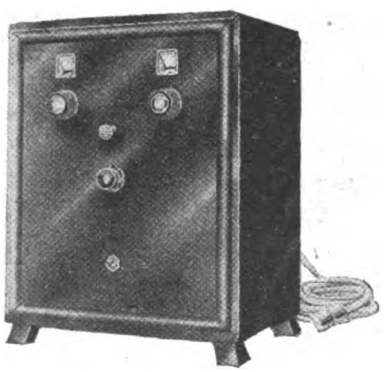
A new trickle charger, the type T.C.5, gives an output of 1 ampere at 2, 4, 6 or 9 volts, the 9-volt tapping being provided for use with certain moving-coil loud speakers, which will not take their full rated field current when operated from a rectifier owing to the high inductance of the magnet winding. The price is £4 7s. 6d. Another new rectifier is one of the Westinghouse type, giving the generous output of 6 amperes at 6 volts.



Interior view of the Ferranti mains receiver.

The urgent demand for a high inductance output choke is met by the new Ferranti type B.5. It is larger than its predecessors, and is listed at 27s. 6d. The resistance is only 40 ohms, and it will carry currents up to 160 mA.

This year marks the introduction of Ferranti radio receivers. This new venture carries with it the high reputation which has been built up in the production of the special Ferranti components of the past and the considerable guidance that has been so much in evidence in the various Ferranti technical publications. Only one type of set is shown. It is an A.C. mains set with two indirectly heated valves, a screened valve being used in the H.F. stage. The H.T. supply is obtained through a valve rectifier, Osram type U.5. The front panel carries two tuning controls, the scales being viewed through recessed apertures. A plunger switch changes the wave range, while the front panel carries, in addition, a volume control and an "on" and "off" switch. A generous refinement is the inclusion of an output transformer with winding suitable for high or low resistance loud speakers. Like other Ferranti eliminator equipment, the mains supply is disconnected on removing the receiver from its containing cabinet. The price is £25.



Ferranti mains receiver.

A new and interesting form of radio switch is now available as a component. Single and double pole models are supplied with various numbers of contact studs. The principle is that of compressed springs moving between parallel plates which carry the contact studs. That these switches are used in Ferranti meters indicates the absence of variation in contact resistance. Prices range from 2s. 6d. to 6s.

The range of Ferranti meters has been extended, particularly as regards the instruments using metal rectifiers and thermo couples.

Ferranti, Ltd., Hollinwood, Lancs.

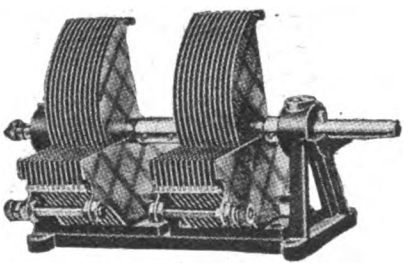
FLINDERS. (282)

This stand is of special interest to retailers in the Eastern counties and carries a selection of the latest radio apparatus.

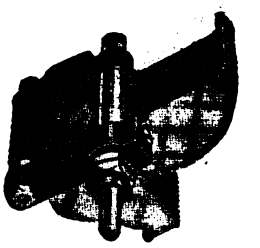
Flinders (Wholesale), Ltd., East Stockwell Street, Colchester, Essex.

FORMO. (72)

Variable condensers predominate in the Formo exhibit. They are exceptionally low in cost, yet compare as regards technical attractiveness with their more expensive competitors. The log condenser, "1930," which is available in four capacity ranges between 0.00015 and 0.0005 mfd., is priced at 4s. 6d. The scrutinising amateur may well see fit to examine this component, and he will find difficulty in noticing any point calling for adverse comment. The fixed plates are securely held in a slotted brass bar, to which also are secured the bakelite end pieces used to support the spindle and its bearings. A merit of the condenser is its extreme rigidity in spite of its apparently light construction. Connection with the end terminal is positive and carries through to the moving plates by a braided pigtail connector in a hollow spindle. A readily accessible friction adjustment is a useful feature, permitting of a smooth movement. Modelled on similar lines there is a reaction condenser with a capacity of 0.0002 mfd., priced as low as 2s. 9d. This also has the internal pigtail connector. A real attempt at the successful ganging of condensers is to be found in the "1930" dual-gang model. In this instance a rigid cast bracket supports the bearings, while the stators, which are first secured to substantial slotted brass pieces are in turn carried on bakelite mouldings. These ganged condensers follow a logarithmic scale, and it is claimed that the capacity change followed by the sections is as close as ¼ per cent. A further development is the screened ganged condenser unit, consisting of three totally separated units. In order that ganging may conform to close limits it is essential to exclude all external stray capacities as well as to protect the plates from mechanical injury.



Formo 1930 Dual Gang condenser.



Formo 1930 Log condenser.

In spite of the complete capacity screening between the units the triple ganged condenser is compact and may be readily associated with the other totally screened equipment of the tuned stages. An adjustment is provided which permits of rotating the stator of one of the units so as to compensate for added capacity which is introduced when the condenser is associated with an aerial circuit. A component of interest to the home constructor is the new and inexpensive vernier dial. An examination of this dial shows it to be free from backlash and of robust construction. The scale is tilted to an angle of 30° from the vertical, thereby permitting of a convenient unobstructed view. Other well-known Formo components are to be seen at the stand including L.F. intervalve couplings, tuning coils and bases, valve holders, short-wave tuning condensers, as well as the Formo-Densor, which is intended for use as a neutralising or reaction condenser.

Formo Company (Arthur Preen and Co., Ltd.), Crown Works, Cricklewood Lane, London, N.W.2.

G.E.C. (85-90)

There are no fewer than seven entirely new Gecophone receiving sets exhibited which, as well as being built around the latest types of Osram valves, embody many new and novel features. Selected as an outstanding receiver from among the exhibits is the three-valve A.C. mains model type B.C.3030. It is of the cabinet variety with mottled front panel at the centre of which is exposed an inclined tuning indicator. On switching on the mains this dial is illuminated by a pilot lamp.

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Single knob tuning is provided, a twin condenser being ganged to the indicator. The dial carries three sets of figures, (a) a scale calibration of 0 to 100, occupying the centre, (b) to the left a broadcast band wavelength scale, and (c) to the right a wavelength calibration for the high-wave range. The scales are marked at

Gecophone three-valve set for battery operation.

intervals of 50 metres, an arrangement which not only simplifies tuning, but assists in the identification of stations. The circuit embodies the use of a screen-grid H.F. stage, and follows a generous power output valve, the use of the latter being possible by using a relatively high voltage H.T. eliminator. Three aerial connections are provided to permit of an adjustment of selectivity. A good feature is the provision of a choke filter output circuit. An interesting detail is the inclusion of an earthing lead in the flexible connector which attaches to the mains. Sensitivity and selectivity combined with high quality reproduction are claimed for this set. The cabinet measures 21in. × 11in. × 12¼in. The price is £25.

Gecophone three-valve A.C. mains set.

Another three-valve set has been designed for use where A.C. mains are not available, yet in order to avoid the unsightly connecting cords provision is made for housing the batteries within the cabinets. The approximate dimensions are 16½in. × 15½in. × 12½in. The circuit principle and operating devices closely follow the model B.C.3030. The output valve supplied is DEP.240, and provision is made for accommodating a pentode (PT.240).

Another new three-valve set is a short-wave receiver. Its circuit departs from the orthodox in that a screened valve precedes the detector, and this, it is understood, enables the set to oscillate easily on all wavebands irrespective of the length of the aerial with an avoidance of "blind" spots. A degree of amplification is claimed for the H.F. stage. The case is entirely of metal, and measures 14in. × 8½in. × 8⅜in. There are two tuning condensers, although a modification by way of increased vane spacing has been introduced. Plug-in coils cover a wave range of 14 to 100 metres, while additional coils could be supplied for broadcast wavelengths.

A four-valve screen grid portable (type B.C.2950/2), stated to be capable of receiving thirty stations when used in London and with a guarantee of twenty-five stations at good loud speaker strength, is of first importance. Two tuning dials are used, though it is pointed out that operation is quite simple, two dials being an essential to the provision of a high degree of selectivity. Good quality reproduction is assured by the use of a generous output valve—the Osram P.240.

Gecophone four-valve screen grid table model.

The case is of waterproof fabric with imitation leather finish and antique red or Cambridge blue in colour. Incorporating a similar circuit and general layout as this portable set there is a four-valve screen-grid table cabinet model in mahogany. Among portables also is an all-electric screen-grid four. It must be admitted that by the use of eliminator equipment better performance, particularly as regards quality, can be obtained as compared with the battery-operated portable. The extensive range of sets also includes a two-valve all-electric receiver. The detector valve, a D.8, is followed by a super-power valve, the P.625A. The eliminator includes a valve rectifier. The price is £15.

Possessors of last year's G.E.C. kit set will be gratified to note that the New Osram Music Magnet embodies but few modifications. It is said that the new coils slightly improve both sensitivity and selectivity. Mechanically the ganged condenser is, perhaps, an improvement on the old type, being more rigid and having a smoother drive. There is an improved intervalve transformer, while the fixed condensers are slightly altered in design to facilitate fixing. The price of the kit complete with Osram valves and cabinet, an addition since last year, is £9.

The new G.E.C. "Stork" cone loud speaker.

Mains power units incorporating valve rectifiers, various attractive types of loud speakers, including a moving coil model, as well as many valves possessing remarkable characteristics are all new introductions at this year's Exhibition. In particular there is the PT.625, a 6-volt super-power pentode. With a working anode voltage of 250 it combines an amplification factor of 80 and an impedance of 43,000 ohms. Additions to the range of A.C. operated valves are the M.S4 (screen grid), M.H4, M.HL4 and M.L4. It is significant to note that the grid to anode capacity of the M.S4 is probably the lowest on record, being no more than 0.0045 micro-mfds. It is this figure that governs the maximum stable amplification obtainable.

The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

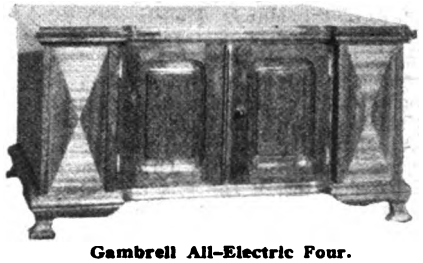
GAMAGE. (258)

Portable sets, loud speakers, and accessories of well-known manufacture are represented at this stand.

A. W. Gamage, Ltd., 128, *Holborn, London, E.C.*

GAMBRELL. (62)

This firm are showing a number of all-electric sets, models with from two valves upwards being produced. The newest type is a transportable with built-in frame aerial; in fact, a self-contained set, except for an external



Gambrell All-Electric Four.

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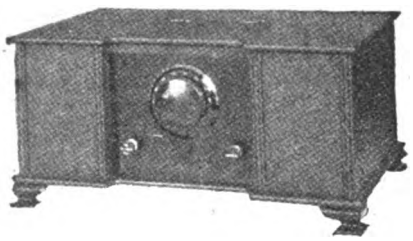
connection to the mains (either A.C. or D.C.). The A.C. version makes use of indirectly heated valves—screen-grid H.F. amplifier, grid detector, and pentode output. A metal rectifier is connected in a voltage-doubling circuit. Provision is made for the addition of a pick-up.

Perhaps one of the most intriguing features of the show is the Gambrell "Novotone," a tone-regulating and correcting device due to Dr. N. W. McLachlan, which can be connected to any electrical gramophone-reproducing apparatus. All too often tone-control devices work only with the help of a good deal of imagination on the part of the user. Not so the "Novotone"; the



Gambrell All-Electric Two.

writer has had an opportunity of hearing it in operation, and can vouch for the fact that it does what it is intended to do, namely, compensates for the usual falling-off in the output of the average pick-up—and sometimes of the amplifier—at the lower and upper ends of the frequency scale. Quite apart from any possible shortcomings of the reproducing apparatus, it is inherent to the process of recording that, as the width of groove must be restricted, the lowest audible frequencies cannot be reproduced at full strength unless some form of artificial aid is invoked; this aid, it is claimed, is supplied by the "Novotone," and, unless the writer's ear is greatly at fault, with complete justification. Further, the reproduction of most kinds of music is noticeably brightened by the inclusion of the device, showing its effectiveness at the other end of the register.

The "Novotone" is included in the new Gambrell Radio Gramophone, which is exhibited and demonstrated.

Gambrell Radio, Ltd., Buckingham House, Buckingham Street, Strand, London, W.C.2.

GODWINEX (J. DYSON & CO.). (1)

A complete range of eliminators, both for D.C. and A.C. mains, is the principal feature of this stand. Models with valve and Westinghouse metal rectifiers are available, and the requirements of the screen-grid valve have been taken into account by the provision of a critically-adjustable output up to 80 volts.

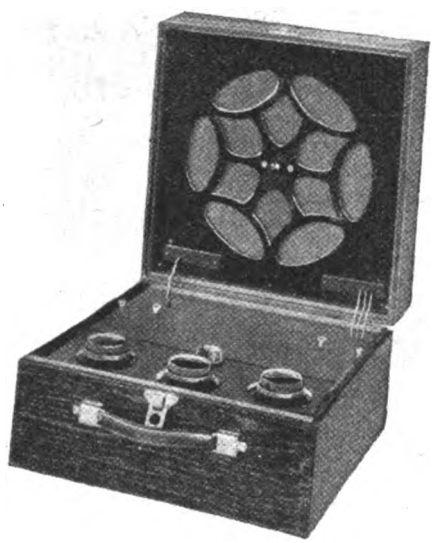
A number of complete receivers are shown. The Screened Grid Portable (H.F., detector, 2 L.F.) is contained in an oak case of suitcase pattern, and is priced at £22. There is also a five-valve transportable model in upright cabinet.

The Godwinex All-Mains three-valve set is provided with a gramophone pick-up connector. An ambitious piece of apparatus is the new All-Electric Radio Gramophone, which embodies such

A typical Godwinex eliminator.

refinements as an electric turntable motor with an automatic stop coming into operation at the end of each record. The price of this instrument is £50, inclusive of royalty.

J. Dyson and Co., Ltd., 5 and 7, Godwin Street, Bradford.



Godwinex suit-case portable.

GOLDSMAN. (280)

This firm is exhibiting two radio-gramophones, both of which are mains-driven, and fitted with indirectly-heated valves. There is also a transportable all-electric radio receiver, which includes a frame aerial and loud speaker. This instrument is completely self-contained except for a connection to the A.C. mains. A battery-operated portable receiver is also shown.

J. L. Goldsman, 100, High Holborn, London, W.C.2.

GOLTONE (WARD & GOLDSTONE). (290)

A display of various wires used in radio work, including flexibles and aerial wire, is made by this firm. They also exhibit various forms of battery-charging apparatus and plug-in coils designed for various popular sets. H.T. battery eliminators, for both A.C. and D.C. mains, are manufactured in various types, at prices of from a guinea upwards. These instruments are also sold in the form of kits of parts for the home constructor. Components on show include H.F. transformers, H.T. batteries, choke coils, fixed condensers, etc.

Ward & Goldstone, Ltd., Frederick Road, Pendleton, Manchester.

GRAHAM. (230)

The chief products of this company are small turned metal components, such as valve pins, valve sockets, plugs, etc. The Norbex valve sockets for flush panel mounting are nickel-plated and well finished. The type with a closed end and coned lug enables all wiring to be clipped on prior to soldering, and is of great assistance where contacts have to be made in inaccessible positions.

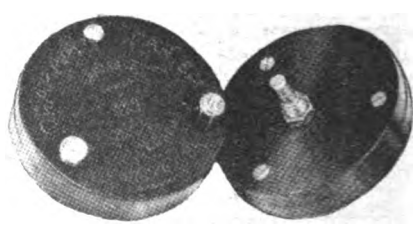
Another type having a long open end, which is threaded and provided with a screw, requires no soldering. For mounting valve sockets on wooden or metal panels, red or black erinoid bushes can be supplied at 1s. 3d. dozen.

R. F. Graham & Co., 45 & 47, Cambridge Road, Kingston-on-Thames.

GRAHAM-FARISH. (140 & 141)

New products introduced by this firm include an H.F. choke with an uneven form of winding divided into a number of graduated sections. It is designed to clip into a standard resistance holder.

An extremely compact condenser with bakelised material between the vanes is also shown. This is in addition to the "Microficient" solid-dielectric condenser, which has been available for some time. This latter component is now supplied in a modified form, with a "dead" spindle and bush, in order that it may be mounted direct on a metal panel. A vernier dial for this condenser is available in an unusual style; the indicator dial is mounted behind the aperture of an escutcheon plate which is secured to the panel.



Graham Farish bakelite-dielectric condenser.

All the well-known components produced by this firm, such as Ohmite resistances, R.C. units, bakelite-enclosed fixed condensers, etc., are retained.

Graham Farish, Ltd., Masons Hill, Bromley, Kent.

GRAMO-RADIO AMPLIFIERS. (247)

All the apparatus shown by this firm, whether for gramophone, radio or cinema work, embodies a distinctly unconven-

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Stand-to-Stand Report.—

tional system of L.F. amplification. The intervalve couplings consist of a kind of air-cored transformer wound with high-resistance wire, with a small condenser bridging the primary and secondary coils.

The list of models exhibited is headed by the "Olympic" Gramo-Radio receiver, which derives all its current from the mains. It is supplied in cabinets of oak, mahogany, burr walnut, or Japanese lacquer, at prices varying between £95 and £115. An electric gramophone, suitable for restaurants, clubs, etc., is also supplied; this model is similarly energised from the mains.

There are also two five-valve receivers, one of which is mains driven. Amplifiers for talking films, as already installed in a number of cinema theatres, are shown.

The C.A.C. low-frequency coupler is available as a separate unit for inclusion in home-constructed sets, in the form of two or three-stage amplifiers at prices from 35s. to £5. These units are compact, the three-stage model, which, incidentally, is supplied, if desired, with 5-pin sockets for A.9C. valves, occupies a baseboard space of but 5½ in. × 4½ in., and weighs only 10 ozs. Readers will be able to judge of the effectiveness of this device, as it is being demonstrated in showrooms in the premises of the Olympia Motor Co., Hammersmith Rd., facing the Exhibition entrance.

Gramo-Radio Amplifiers, Ltd., 1a, New London Street, London, E.C.3.

GRIPSO (L. H. REID & CO.). (227)

This stand is devoted to the display of small fitments, such as earthing clips, spade ends, and wander plugs. The Gripso on-off switch, with revolving dial showing through an aperture, will be familiar to many readers; it is now being produced in multi-pole form.

L. H. Reid and Co., 32, Victoria Street, London, S.W.1.

GROSVENOR. (287)

On this stand is to be found a comprehensive range of high-tension dry batteries. The chief feature exhibited is a series of batteries specially constructed for portable sets. A number of well-known manufacturers are now fitting them as standard equipment.

Grosvenor Battery Co., Ltd., 2-3, White Street, Moorgate, E.C.2.

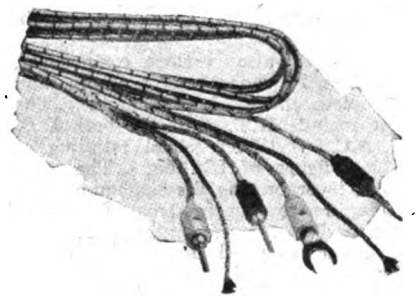
HALCYON. (136 & 171)

The products of this firm—portable receivers exclusively—remain substantially unchanged since they were described in *The Wireless World* Portable issue. There has, however, been an all-round reduction in price; for example, the "Cabinet Five" now costs 32 guineas, and the "Screened Grid Four" is priced at 28 guineas. Specimens of the various models are on view.

The Halcyon Wireless Co., Ltd., Canberra House, 313-319, Regent St., London, W.1.

HARBROS (HART BROS.). (239)

The exhibits on this stand include many forms of flexibles such as are required for the connecting up of radio receivers and extension equipment. Known as "Harbros Easyfix," is a useful braided twin conductor possessing reasonably low capacity between the two leads and which can readily be attached around



Harbros battery cable.

walls and skirting boards. It is useful for a number of radio purposes, and in particular loud speaker extensions as well as for remote control circuits. Well-finished multi-lead battery cables are also shown providing a tidy form of connection between the receiving set and source of current.

Hart Bros. Electrical Manufacturing Co., Ltd., Queensway, Ponders End, Middlesex.

HARDYSON. (158)

A range of five receivers and radio gramophones is available. The "Standard" model, selling at 35 guineas, has three valves—detector and two L.F.—and there is provision for a gramophone pick-up. There are two tuning controls, the loud speaker is self-contained, and the set contains means for all-mains operation either from D.C. or A.C.

The "Queen Anne Table Grand," selling at 37 guineas, embodies four valves, the first being an S.G. valve, followed by a regenerative leaky grid detector and two L.F. valves. There is provision for a gramophone pick-up, and the receiver derives its current from either D.C. or A.C. mains. The Screened-Four battery radio gramophone has the same circuit as the last receiver, but no means is provided for deriving current from the mains.

The *De Luxe* Screened-Five, selling at 70 guineas, is an elaborate equipment for A.C. mains, and contains a moving coil speaker.

Hardyson Radio, Ltd., 13, Market Street, Huddersfield.

HARLIE. (277)

Three types of high-class radio gramophone are shown. They are entirely self-contained. The "Orchestral" is a generous and attractive installation suitable for hotel use, and selling at £152 10s. This set is mains-operated, whether A.C. or D.C., and it is understood that the output stage comprises L.S.5a valves in push-pull. Slightly less ambitious, but equally attractive, models fitted with almost similar electrical equipment are the "Salon" (£138 10s.) and the "Chamber" (£118). Complete moving-coil loud speakers, with windings for accumulator or D.C. mains, are available at £3 10s. The Harlie pick-up and tone arm is a new component. A folding swivel joint on the end of the arm is a novel and useful feature, permitting of the removal of the pick-up from the record. Complete with a weight adjustment and self-contained volume control, the price is £1 17s. The Volustat, another new component, is a continuously variable resistance having a power-dropping rating of 10 watts.

Harlie Bros., Balham Road, Edmonton, London, N.9.

HART ACCUMULATORS. (289)

There are a large number of listeners who prefer a source of high-tension supply of negligible internal resistance to avoid all the complications of back-coupling, and employ high-tension accumulators, even though they have electric lighting in their houses. To these, and owners of sets who have not electric light, the wide range of high-tension accumulators will appeal. The "RAO" type have a capacity of 1,250 milliampere-hours. The containers are moulded glass boxes, the lids are of ebonite, and the plates, having a complete envelope of perforated ebonite preventing the dislodging of active material, are worthy of attention.

The "Raydax" type, having a capacity of 3,000 mA. hours, is useful where heavy consumption power valves are used.

Hart 10-volt H.T. accumulator unit.

For anode currents of 100 mA. and upwards the "Beamex" cells with a capacity of 10,000 mA. hours are available. With large differences of potential between terminals, surface leakage and corrosion can be serious with H.T. cells; it is thus of interest to find that this company has paid special attention to these points, and not only provides effective inter-cell insulation, but also uses a special terminal alloy, not containing brass, which entirely resists the action of acid.

For portable sets there is an unspillable L.T. accumulator designed to operate in two positions. For tropical climates, or under conditions where change of temperature may be an important factor, the "MEZ" L.T. cells in ebonite containers are recommended.

On this stand can be seen accumula-

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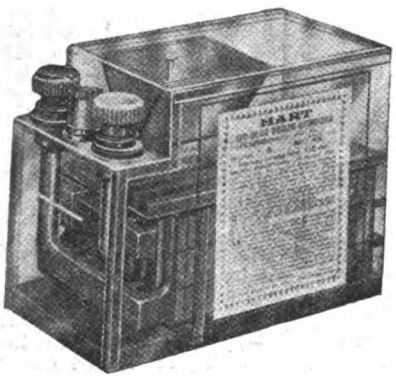
Stand-to-Stand Report.—

tors of every voltage and capacity that are likely to be required in connection with radio.

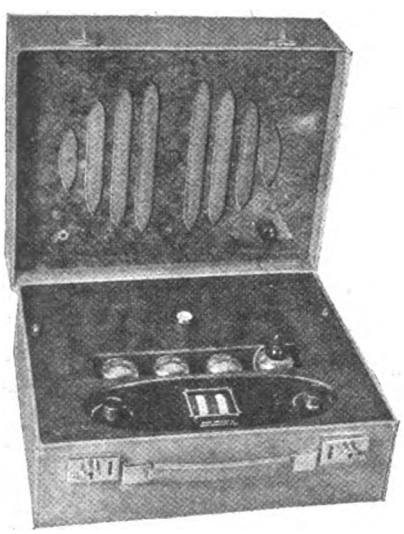
Hart Accumulator Co., Ltd., 35, *Marshgate Lane, Stratford, E.*15.



Hart unspillable accumulator for portables.

HART COLLINS. (49)

The principal exhibits are the "Passport" portable receivers. The four-valve screen-grid model in leather attaché case sells at £21 5s. complete, and the more ambitious *de luxe* model at £23 10s. The latter is contained within a cabinet of solid walnut, and is fitted with a Celestion loud speaker. Particular attention has been paid to the total anode consumption, which is under 10 mA. Provision is made in both models for the connection of an external loud speaker,



The Hart Collins "Passport" receiver—a screen grid portable.

and, if desired, a Fultograph wireless picture receiver can be attached.

In the programme for this season there are all-mains receivers.

Hart Collins, Ltd., 38*a*, *Bessborough Street, S.W.*1.

HENDERSON. (201)

Among this firm's exhibits will be found a new receiver designated the "U" two-valve portable. A Mullard loud speaker is included, and the dimensions are 8¾in. × 12in. × 8in., the total weight being only 19¾lb. This portable sells at 11 guineas.

Other portable receivers include type "T" retailing at 17 guineas, and type "S" at 25 guineas; they both contain five valves.

There are also various components, such as H.F. chokes and switches, and a complete range of eliminators. The latter include H.T. units for both D.C. and A.C., the D.C. model retailing at the low figure of 29s. 6d. The A.C. models, incorporating Westinghouse metal rectifier, range in price from £4 10s. to £7 10s.

A radio gramophone is also being shown.

W. J. Henderson & Co., Ltd., 351, *Fulham Road, S.W.*10.

HOBDAY. (252 & 253)

Acting as distributors for the trade, this company is exhibiting a comprehensive range of the new season's components and accessories.

Besides the products of other firms, they have a number of interesting components of their own. These include dry batteries, switches, chokes and ebonite.

Hobday Bros., Ltd., 21-27, *Great Eastern Street, E.C.*2.

HOUGHTON-BUTCHER. (242-245)

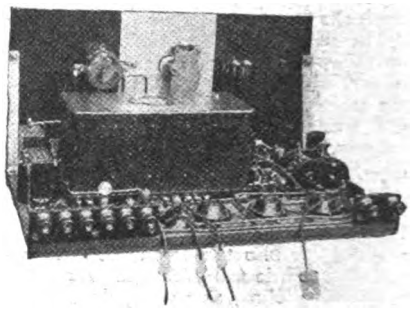
Here the radio dealer will find arranged a selected number of new lines, those, in fact, which in Houghtons' opinion are going to prove the most popular of the coming season.

Houghton-Butcher (Great Britain), Ltd., 88-89, *High Holborn, London, W.C.*1.

IGRANIC. (161 & 162)

As it is representative of typical modern practice in the design of a receiver intended for the requirements of the average wireless user, the new "A.C.3" will perhaps be considered to be the most interesting Igranic exhibit. Three indirectly-heated A.C. valves, functioning normally as screen-grid H.F. amplifier, detector and pentode L.F. magnifier, are used, while in each model provision is made for gramophone reproduction by a switching arrangement whereby the pick-up is automatically connected across detector grid and filament, with appropriate negative bias—which, by the way, is obtained from a battery, although L.T. and H.T. current are derived from the mains, the latter through a U.5 double wave rectifying valve. The set is supplied in three distinct models: Table, Bureau, and Radio-Gramophone, the first-mentioned being intended for operation with an open aerial, while the other two are provided with built-in non-directional frame aerials. Both these models have Igranic-Pacent cone loud speakers housed in the base of their cabinets and operated by a balanced armature unit of particularly workmanlike design.

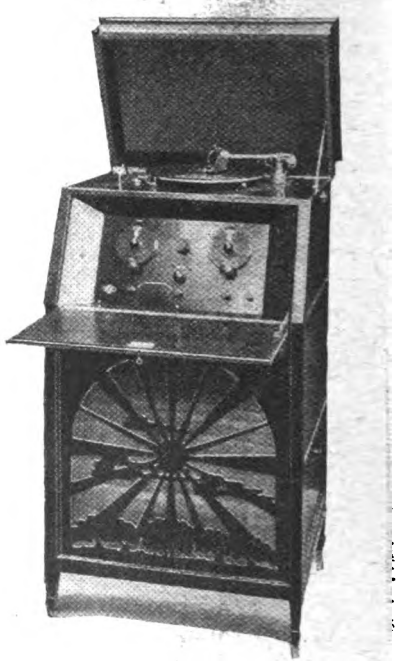
The circuit arrangement is fairly conventional, but it is observed that complete decoupling of the anode circuits is included, and that a choke-filter output device is provided. Metal enters largely



Igranic short-wave superheterodyne.

into the construction of the set, as the various units and screens are assembled on a frame of L-section aluminium.

Another entirely new set is the "Neutrosonic" Short Wave Receiver, a compact and distinctly promising short-wave version of the well-known "Neutrosonic Seven" (which, by the way, is produced this year in a new type of cabinet with built-in moving coil loud speaker). The short-wave superheterodyne, covering the band between 12.5 and 70 metres, has a total of six valves, including a signal-



Igranic A.C. Three radio gramophone.

frequency amplifier before the detector. As choke aerial input and an autodyne oscillator circuit are employed, there is but one tuning control. Considering its possibilities, the price of this receiver (£23 without valves or batteries) may fairly be considered as exceptionally low.

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Stand-to-Stand Report.—

Turning to components, we find that a new range of double-waveband coils has been produced. There are three distinct types: aerial coil (or tuned anode), neutralised H.F. transformer and screen-grid H.F. transformer. Each is mounted in a neat moulded bakelite case, and is intended to be used with a simple on-off switch for waveband changing. Provision for reaction is included in each case. Regarding the screen-grid H.F. transformer, it is stated that the primary impedance is designed to match the average present-day valve. In order to

Igranic Neutrosonic Seven: cabinet model.

simplify wave-changing, a fixed primary is used; it is carefully disposed in order to afford the best possible compromise between ideal conditions on both wavebands, with a slight bias in favour of the medium waves, where maximum efficiency is most needed.

Although it is not, strictly speaking, a new product, mention should be made of the Igranic Transverse Current Microphone, described in our Manchester Show Report last year. This component seems to be finding an increasingly wide field of usefulness in connection with public address and other work of a similar nature.

All the well-known Igranic components are retained, with, in several instances, minor alterations and improvements in design.

The Igranic Electric Co., Ltd., Elstow Works, Bedford.

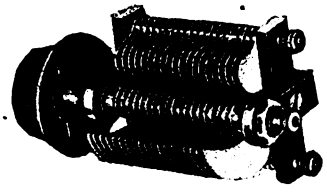
ITONIA. (286)

In addition to various radio receivers and accessories of leading makes, a portable receiver, a product of this company, is also shown. This set, the Autocrat Portable Five, is fitted with an Air Chrome loud speaker, a type in which a double diaphragm is used, and which is separately exhibited on the stand.

Itonia Gramophones, Ltd., Itonia House, 58, City Road, London, E.C.1.

J.B. (JACKSON BROS.). (97)

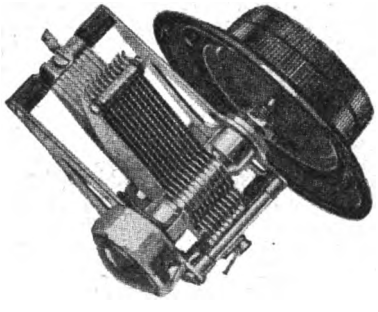
This firm now produces such an extensive range of variable condensers that it is impossible to enumerate, let alone to describe, all the various types. In view of the present vogue for condensers of small physical dimensions—brought about by the need for economising space in screening compartments, and also to



J.B. Midget condenser.

the demands of the portable set builder—attention will be focused on the new "Tiny" pattern. These little condensers are supplied with knob, pointer and scale, have an 8 : 1 reduction gear, and are provided with a ball bearing and pigtail connector. The 0.0005 mfd. model costs 10s. complete.

The Universal Log Condenser is a high-grade product, and one need hardly say more than that it is a real engineering job. Both vanes and frame are of hard brass. The steel centre spindle is adjustable as to its length, so the component should be handy for mounting in unconventional ways—as, for instance, in screening cabinets of the type lately described in this journal. Lugs are fitted so that the condenser may be mounted on the baseboard.



J.B. slow-motion condenser.

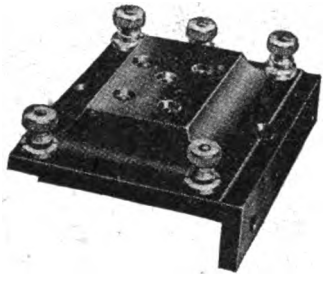
Several different patterns of edgewise drum dials (both direct and slow-motion) are exhibited. In particular a double-drum gauged unit, with single operating knob, has been produced and is specified for use in the new Mullard "Orgola" receiver. Special short-wave condensers, in capacities of 0.0001 mfd., 0.00015 mfd., and 0.00025 mfd., have phosphor-bronze balls in their bearings and increased air spacing between the vanes.

Jackson Bros., 72, St. Thomas Street, London, S.E.1.

JUNIT. (207)

A neat universal valve-holder is being shown. Having five sockets, one of which is central, screen-grid valves, triodes, and the new type of pentode can be accommodated. Provision is made for vertical or horizontal fixing. The special spring clip into which the valve legs fit is so designed that it makes positive contact along three surfaces of each valve leg. The valve-holder, having a bridge structure, enables the wiring when required to be carried underneath. A vertical terminal strip mount, with horizontal fixing ledge to prevent the possibility of splitting the wood of the baseboard, is also to be seen on this stand.

Junit Manufacturing Co., Ltd., 2, Ravenscourt Square, W.6.



Junit 5-pin valve-holder for vertical or horizontal mounting.

"K.N." ELECTRICAL PRODUCTS. (254)

This firm specialise in the manufacture of wireless receivers for the trade, and exhibit a number of sets to show their capabilities in this direction. There is a neat H.F.-det.-2-L.F. suit-case type of portable with a tuned H.F. coupling which embodies a metal chassis construction, also a complete portable radio-gramophone with a more or less conventional two-stage H.F. amplifier followed by a detector and two L.F. stages. The "Cube" model is particularly compact. A three-valve all-mains receiver is also shown.

"K.N." cabinet cone loud speakers include an auxiliary balancing mechanism in their drive units, and are manufactured in various types.

"K.N." Electrical Products, Ltd., 5 and 7, Singer Street, Tabernacle Street, Finsbury, E.C.2.

KABILOK (W. T. LOCK). (202 & 203)

A fine display of cabinets, of almost every imaginable type, is made on these stands. Not only are there containers for sets and radio gramophones, but also for loud speakers, of both the moving coil variety and the reed-driven type. The constructor is catered for by the provision of special models suitable for use in assembling cone loud speakers with the help of the popular drive units.

A pedestal gramophone cabinet, suitable for accommodating a typical "kit" set, has just been produced. It provides space for the set itself, and also for motor, turntable, and batteries or eliminator. A loud speaker can be built into the lower compartment.

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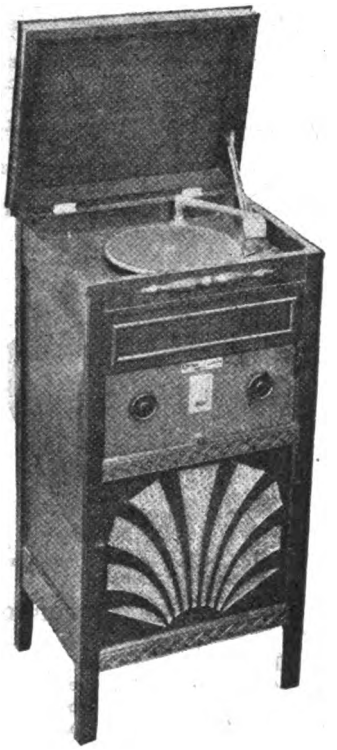
Table cabinets for all the well-known "kit" sets are exhibited, including one for the "transportable" version of the Mullard S.G.P.

W. and T. Lock, Ltd., St. Peter's Works, Bath.



Lock gramophone cabinet for kit sets.

KALISKY. (24 & 25)

This firm is showing a range of their own products, sold under the trade name of "Sopranist," such as accumulators and transformers, etc., as well as a number of proprietary sets, loud speakers and components, for which they are agents.

S. Kalisky (Aldgate), Ltd., 75, Aldgate High Street, London, E.C.3.

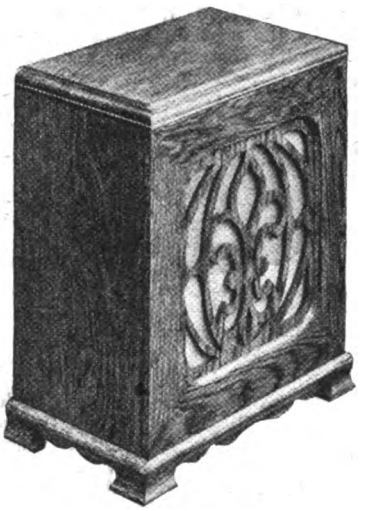
KEITH PROWSE. (228)

On this stand is displayed a representative range of portable and cabinet receivers, including those made by Burndept, Aeonic, Truphonic, McMichael and Halcyon.

Keith Prowse and Co., Ltd., 159, New Bond Street, W.1.

KOLSTER-BRANDES. (176-179)

This company has embarked upon the manufacture on a large scale of popular-priced receivers. As an instance of a well-designed receiver conforming to the latest practice, mention should first be made of the K-B.102 set, which sells, complete with valves and royalties, at £9 15s. A screen-grid H.F. amplifier is followed by a leaky grid detector, which, in turn, is followed by pentode output. Accurate tuning is facilitated by drum controls and vernier adjustment. The K-B.161 set is entirely mains-driven, and, although the circuit is similar to the K-B.102, greater selectivity is got by the use of a double-tuned circuit, together



The K-B.72 balanced-armature speaker by Kolster-Brandes.

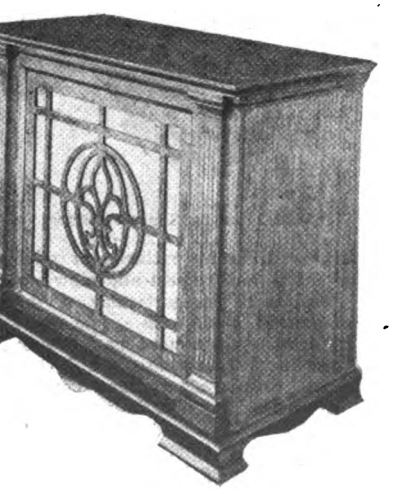
with a reaction condenser. To prevent overloading of the last valve a volume control is included. The receiver, ready to plug into A.C. mains, is £17 10s. complete.

A battery-fed model, having the same circuit and provided with a gramophone pick-up jack, sells at £10 15s. The K-B suit-case portable set, having a balanced armature cone speaker in the lid, is priced at 18 guineas. There are four valves, the first being an S.G. valve, and the last two being linked by L.F. transformers. The aerial and inter-stage inductances are tuned by thumb-dials with vernier adjustments.

A radio-gramophone, designed to operate from A.C. supply mains, contains a three-valve set substantially the same in design as the K-B.161 receiver. There is also included a spring-driven motor, capable of playing three records at one winding, and a K-B.131 pick-up. The K-B. electric gramophone contains a two-stage L.F. amplifier, the first valve of which has an indirectly heated cathode; this is coupled to two output valves in parallel. A liberal smoothing equipment follows the full-wave rectifying valve. A K-B. gramophone pick-up, a moving coil speaker, and electric motor with 12in. turntable, are included. The whole equipment, which is capable of giving sufficient volume for a small hall, is thus A.C. mains-operated.

The well-known Brandeset 3A and 3B receivers and the Ellipticon cone loud speaker are being retained for the new season, as are also the Brandes accumulators.

Kolster-Brandes, Ltd., Cray Works, Sidcup, Kent.



The K-B.151 Dynamic speaker made by Kolster-Brandes.

Kolster-Brandes 4-valve screen-grid portable.

L.E.S. (LONDON ELECTRIC STORES). (293 & 294)

Radio wholesalers and distributors. It should be noted that the name of this company has been changed to "L.E.S. Distributors, Ltd.," taking effect from September 23rd.

L.E.S. Distributors, Ltd., 9, St. Martin's Street, Leicester Square, London, W.C.2.

LAMPLUGH. (126 & 127)

The buying of a receiver in an elaborate and expensive container may fairly be considered an extravagance when one has standing idle a cabinet or other piece of furniture suitable for housing the apparatus. No doubt many potential wireless users are so situated, and, to cater for them, this firm has introduced "Chassirad" receivers—complete sets, but with no containers other than the metal cases in which they are built. The first is an

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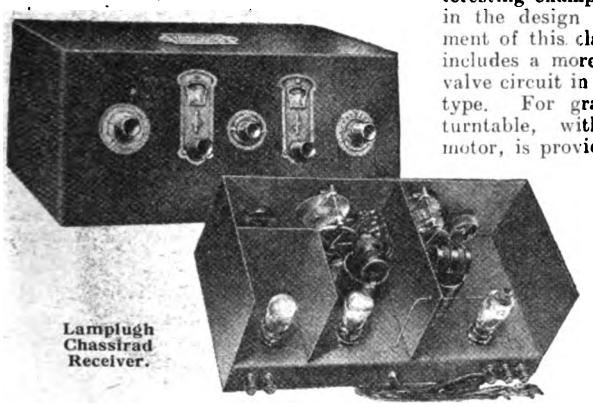
Stand-to-Stand Report.—
H.F.-det.-L.F. combination, including such modern refinements as waveband switching, separate reaction windings for each waveband, and complete screening. The metal casing of this set is complete, and is finished in an improved form of "crackle" enamel; actually, many would consider it good enough to use without any camouflage. The second set is a three-valve outfit (det.-2 L.F.) similarly built on a metal chassis, with only the valves exposed. Both these sets are excellent samples of modern manufacturing practice.

The "Silver Ghost" is a good-looking receiver embodying the same circuit arrangement as the "Chassirad," but mounted either in a table cabinet or on a console pedestal with built-in loud speaker.

Two-and three-valve all-mains sets are also exhibited. Both these models are fitted with provision for connecting a pick-up.

A radio-gramophone with a three-valve det.-L.F. combination has just been introduced. A B.T.H. pick-up is fitted as standard, and the set is provided with a volume control in the L.F. coupling, which is consequently effective both for gramophone and wireless reproduction.



Lamplugh Chassirad Receiver.

There are also a range of components, including eliminators for A.C. and D.C. supplies.

S. A. Lamplugh, Ltd., King's Road, Tyseley, Birmingham.

LANGHAM. (59)

"The Langham Blue" is a five-valve portable set with two choke-coupled H.F. stages, followed by regenerative leaky-grid detector and two L.F. stages, which are resistance- and transformer-coupled respectively. The total anode consumption is under 9 mA. Provision is made for the use of a gramophone pick-up, and the receiver in a case covered with blue leather cloth sells at 18 guineas (including royalties).

The "Popular Five" sells at the low figure of 16 guineas, and has a single tuning control of the vernier drum type. Waveband switching and a separate volume control are provided.

Langham Radio, Ltd., Exhibition Works, Wembley.

The Langham-Blue portable receiver.

LAW (LOCK-ATKINSON). (257)

An exhibit of screens and screening boxes, including several designs specified in this journal, is a feature of this stand. "Kilo-Mag Four" coils are also shown.

The LAW radio-gramophone is an interesting example of extreme compactness in the design of a dual-purpose instrument of this class. On the radio side, it includes a more or less conventional five-valve circuit in a container of the suitcase type. For gramophone reproduction, a turntable, with Garrard double-spring motor, is provided, together with a pick-up on a pivoted arm, which is neatly arranged to fold back into the lid when not in use. A Celestion loud speaker is fitted to this model. The set is nicely finished, the case being covered in antique hide with oxidised silver fittings. Batteries and gramophone motor are stowed in a separate compartment to which access is easily obtained by opening an extra lid in the base.

Several other portable and transportable sets are shown, including a cheaper model at 14 guineas. There is also a large cabinet radio-gramophone, which is so arranged that it can be supplied with the necessary equipment for operation from the mains.

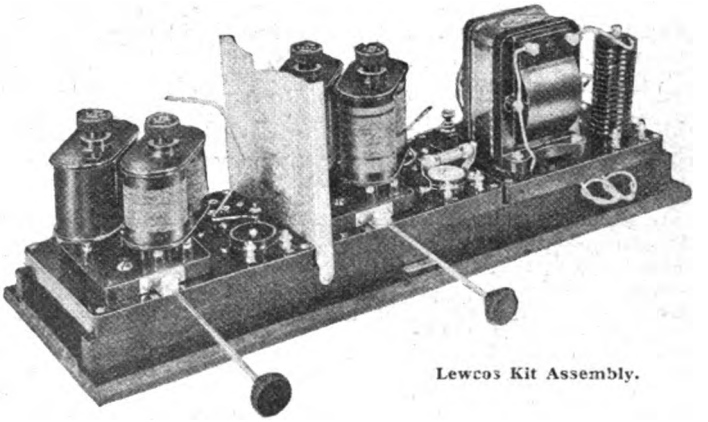
Lock Atkinson Wireless, 95, Great Titchfield Street, London, W.1.

LEWCOS (LONDON ELECTRIC WIRE CO. & SMITHS). (64)

"From the copper ingot to the complete set" would not be a bad slogan to apply to the new "Three-valve Kit Assembly" produced by this well-known firm of wire manufacturers. Actually, some slight qualification would be necessary, as the set as supplied is not quite complete, requiring merely the addition of some form of container, three variable condensers, and an on-off switch. It is intended that the receiver shall be housed in an existing piece of furniture or in an American style cabinet of conventional design.

An entirely novel method of construction has been adopted in this set, which comprises a screen-grid H.F. valve, transformer-coupled to a grid detector with reaction, which is linked by the new "Lewcos" L.F. transformer to a single output valve. The three valve units—H.F., detector, and L.F.—are mounted on bakelite baseboards, which include spring-suspended valve holders and also carry mouldings for accommodating the coils, which are of the fieldless binocular type, long- and medium-wave inductances being mounted side-by-side. Waveband switching is quite unorthodox, as the coil bases are moved bodily through push-rods; connection to the various points is made through springy contacts on the underside of the bases, which engage with corresponding studs on the chassis.

Provision is made, by means of a metal strap, to effect the necessary filament circuit modifications for using either directly heated battery valves or indirectly heated A.C. valves. Where maximum range and volume is desired, a pentode may be fitted in the output socket. It is no exaggeration to say that the set can be wired up to give signals in a few minutes, as all the internal connections have already been made.



Lewcos Kit Assembly.

It is generally admitted that the ab-

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sorption type of wavetrap, if properly designed, is the most satisfactory instrument of its kind; those who find difficulty in eliminating a powerful local station will be interested in a new piece of apparatus, designed to fit on the aerial-grid coil of an existing set, which is shown for the first time. The capacity-inductance ratio of the absorbing circuit has been well chosen; the condenser, of the semi-variable type, is of comparatively large capacity, and is mounted on top of a moulding carrying a litz wire coil. The range of usefulness of this neat little gadget is limited by the fact that it cannot easily be coupled to every type of coil, but, with a little ingenuity on the part of the user, it should be adaptable to a large number of sets.

Mention has already been made of the new "Lewcos" L.F. transformer; this component, which has a 5 : 1 step-up ratio, is designed with an eye to the popular type of set in which a grid detector (with or without a preceding H.F. amplifier) is followed by a single L.F. stage.

It would be quite impossible, in the space available, even to give a bare list of the wide range of coils and H.F. transformers on this stand, but mention should be made of a new dual-range binocular coil mounted on a base with built-in switch, and of a new plug-in inductance coil with three tappings led out to terminals disposed round the casing.

It is hardly necessary to add that specimens of every conceivable type of wire applicable to the radio art are on view.

*The London Electric Wire Co., and Smiths, Ltd., Church Road, Leyton, London, E.*10.

A D.C. eliminator at a popular price, made by Lissen.

LISSEN. (184-186)

Included among the products for this season are two D.C. eliminators selling at popular prices. To the keen student who follows the latest accepted practice these units should prove of special interest. After the usual choke-condenser smoothing circuit, potentiometer-feed for screen current is provided by means of fixed series resistances in type A model, and by a continuously variable wire wound resistance in type B. The latter unit also contains a variable control for detector plate voltage—a desirable refinement with leaky-grid rectification. Series feeds are used for the other two H.T. positive tappings, which deliver a total of 12mA.

The units are housed in neat circular bakelite mouldings about 4in. in diameter, and the space around the components is filled with wax to prevent derangement should the eliminator be dropped. Type A sells at 27s. 6d., and type B at 39s. 6d.

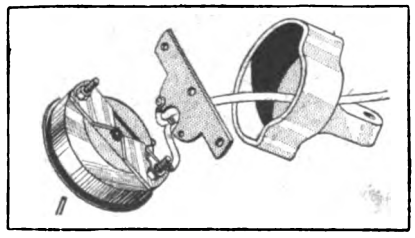
Lissen volume control with rocking plate contact.

It is understood that the wire-wound variable resistances referred to, which are only about 1¼in. in diameter, will be available separately; the fine wire resistance element is wound on a circular former to which contact is made by an ingenious flexible metal rocking plate, so that there is no rubbing action.

For grid circuits where there is no D.C. component a new potentiometer volume control is available. The same rocking plate form of contact is used, but the resistance element of 500,000 ohms is not wire-wound. For radio-frequency or gramophone pick-up circuits this component should have considerable appeal at 4s. 6d.

A new gramophone pick-up, contained in a bakelite moulding, is of distinctly interesting construction. A spear-point needle is used, held by a rubber washer, and is limited in axial movement by the diverging blades of the spear-head, while the end of the needle remote from the point is free to move in the small gap between two large V-shaped pole pieces. The needle, which thus becomes the armature, is the only moving part; the price is 30s.

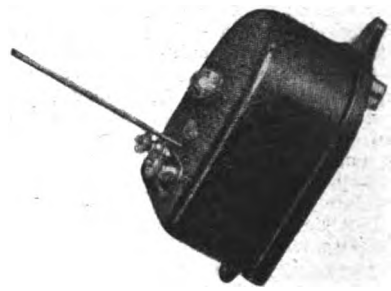
A new range of eight two-volt valves, including two pentodes and a screen-grid valve, are now on the market. The screened valve—called the S.G.215—has an amplification factor of 180, an A.C. resistance of 200,000 ohms, and a mutual conductance of 0.9 mA. per volt. The super-power pentode—the P.T.240—has an A.C. resistance of 22,500 ohms and an amplification factor of 45, giving a slope of 2 mA. per volt. As an indication of the grid swing that the valve will accept at 100 volts on both anode and screen the recommended grid bias is 7½ volts negative.



The Lissen pick-up in which the spear-point needle is the armature.

There are no fewer than twelve radio-gramophones, ranging in price from £30 to £49 12s. 6d., the less expensive models are battery-fed and the more elaborate machines are equipped with A.C. or D.C. eliminators and moving coil loud speakers. Where the design includes mains equipment an electric gramophone motor can be incorporated for a small extra charge.

An interesting feature in connection with the five-valve Lissenola portable set selling at £16 16s. is the extremely low total H.T. consumption of 8 mA. This is brought about by careful attention to the negative biasing potentials of the two 3-electrode H.F. valves, as well as that applied to the L.F. valves.



Balance-armature cone unit—a Lissen product.

Among a host of other components are H.T. and L.T. accumulators, cone units, and a Combinator which allows the rapid construction of an R.C.C. unit from fixed condensers and resistances. The super-transformer, selling at 19s., and the S.G.3 kit receiver, well known to readers, are still contained in the programme for 1930.

Lissen, Ltd., Friars Lane, Richmond, Surrey.

LITHANODE. (232)

A new range of Lithanode L.T. accumulator batteries in glass cases are shown for the first time. These include the special plates used in the other products of the firm, and are sold at relatively low prices. A special high-capacity battery, suitable for withstanding the demand of, say, a big amplifier with a number of L.S.5 type valves, and at the same time feeding a moving coil loud speaker magnet winding, is another new product.

A number of single unspillable cells, with ampere-hour capacities up to 40, are exhibited. These are of the type so widely used for portable sets.

On this stand is also exhibited the Metropolis portable set, embodying a very unusual supersonic heterodyne circuit. A total of five valves is employed, including two of the screen-grid type, two triodes, and a pentode in the output position. Both weight and overall dimensions are below the average.

The Lithanode Co., Ltd., 190, *Queen's Road, Battersea, London, S.W.*8.

LOEWE. (291)

Particular interest attaches to the Loewe exhibit in view of the application of the well-known Loewe multiple valve to the design of popular receiving sets. A local station receiver (type O.E.333) is

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Stand-to-Stand Report.—
virtually a three-valve receiver, comprising a detector valve with two resistance-coupled L.F. stages. The receiver contains tuning coils and variable condenser together with a lever pattern "on" and "off" switch, while terminals are avoided by the provision of battery connecting leads. The aerial circuit is loose-coupled and is therefore particularly selective, and the arrangement of interchangeable coils permits of the reception of Daventry 5XX. An anode voltage of 90 is specified and an L.T. supply at 4 volts.

Although of very similar external appearance a modification to the above receiver is found in the type R.O.433, in which provision is made for the use of reaction. The aerial circuit is loose-coupled as before, though in this instance the secondary coil is tapped to permit of the introduction of capacity reaction. A small lever near the base is provided for this purpose. A.C. battery eliminators are available for use with these receivers. The price of the O.E.333 is £3 3s., and the R.O.433 is £3 10s., in each case complete with coils for the lower waveband and valve.

Loewe valves complete with the necessary multi-contact sockets are obtainable in three types. For detector and two L.F. circuits there is the type 3N.F., while for combining a single radio frequency stage with a single low frequency

Loewe receiver. Type O.E.333.

amplifier there is the type R.N.F.7. These valves cost £2 3s. 6d. A two-stage H.F. valve, type 2H.F., costs £1 12s. 6d. It is appreciated that these valves do not only contain the valve elements, but include in addition the associated intervalve couplings of the resistance type. The filament voltage is 4 and the current consumed is 0.3 ampere in respect of the three-section valves.

Attractive cone loud speakers are also shown, intended specially for use with the Loewe sets, the combination forming a particularly simple receiving outfit. In addition, there is a gramophone pick-up, and it is to be noted that sockets are available on the side of the receivers to permit of its use without modification.

The Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15.

LONDON RADIO MFG. CO. (112)

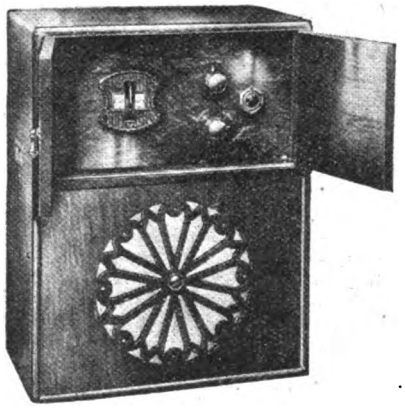
Amongst the various loud speakers shown on this stand the Orphean cone at 29s. 6d. represents good value for money. The circular cone of the speaker is supported in an 11in. square bakelite moulding, and the movement consists of a reed-driven cone which is adjustable. The speaker is so constructed that it can either stand on a table or hang from a picture rail. The "Super" cabinet speaker, with an 11in. cone in a polished domed cabinet of oak, is priced at £6. Space is left within the cabinet for the necessary components that go to make up a two-valve amplifier such as would be used after a gramophone pick-up. There is a popular cone and chassis housed in an 11in. square cabinet which sells at the moderate figure of 70s. complete.

The "Standard" cabinet cone, contained in a well-finished ornamental cabinet in which there is no space for an amplifier, sells at £3 15s.

London Radio Mfg. Co., Ltd., Station Road, Merton Abbey, S.W.19.

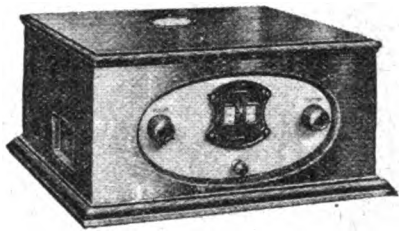
LOTUS (GARNETT, WHITELEY & CO., LTD.) (63)

A visit to this stand reveals at once this season's trend in radio receiver design. A typical up-to-date receiver is the Lotus three-valve all-mains transportable. It is an entirely self-contained set with indirectly heated screen-grid and detector valves, followed by pentode output. A valve rectifier furnishes the H.T. and grid biasing potentials. Being fitted with cone loud speaker and self-contained frame aerial the only connection required is a two-pin plug to the electric supply. To avoid the necessity of swinging the entire receiver the frame aerial is carried on a hinged door at the back of the set. Edgewise thumb-dial tuning with two scales side by side renders control quite simple. There is a two-range switch and a reaction knob. The front panel also carries a pilot lamp,



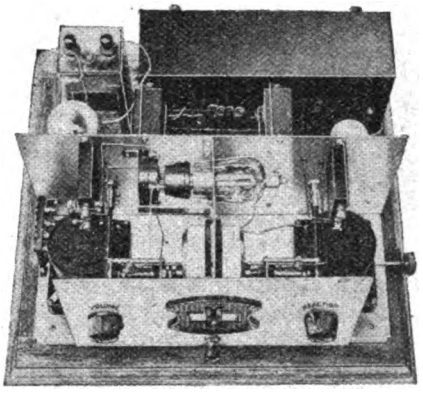
Lotus three-valve all mains transportable

indicating the turning on of the current. The well-finished cabinet can be had in oak, walnut, or mahogany at prices from £25 4s. to £26 5s.



The Lotus three-valve S.G.P. all-mains receiver.

Another all-mains set is the Lotus receiver, type S.G.P. Here, again, we find the combination of indirectly heated screen-grid and detector followed by pentode. Metal panels support and screen the various components. It incorporates a full wave valve rectifier with generous smoothing equipment. The general external design is that of a well-finished cabinet with an oval front aperture exposing a metal panel which carries the controls. With oak, walnut, or mahogany cabinet the price is £21. It



Lotus three-valve S.G.P. kit set.

is claimed that the reproduction of this receiver is worthy of the adoption of a moving-coil loud speaker. It is stated also that reaction, although provided, need not be forced in view of the high efficiency of the H.F. amplifier. Tuning is said to be simple, due, in the first place, to the generous amplification and, in the second, to the tuning controls being of the adjacent thumb-operated type combined with the close matching of the coils. Three alternative tappings are provided to suit different aerials and locations. Wave change is effected by a knob situated on the side of the set. Provision is made for a gramophone pick-up attachment. The wave ranges are 200-550 and 1,000-2,000 metres. Where A.C. mains are not available a corresponding set, priced at £13 15s., is available for battery working.

Of almost similar construction to the above are two sets, the parts for which are in the form of a kit. The main

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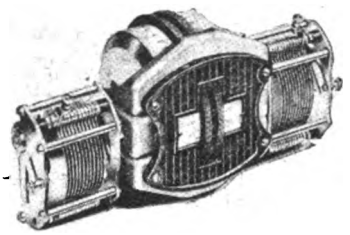
Stand-to-Stand Report.—components are mounted in position on the metal panels, and full instructions are given for assembling. The attractive layout of the components will make a strong appeal to the home constructor. Without valves the price of the D.C. model is £7 12s. and the A.C. model, including H.T. eliminator, £14 10s.

A four-valve suitcase portable is also exhibited. It makes use of two screen grid stages, detector, and pentode output, and the price is 19 guineas.

Additions to the range of Lotus components include an all-mains unit, various power transformers, and a generous eliminator smoothing choke. Of attractive appeal, however, are the double- and single-drum dials, of which the dimen-



Lotus drum vernier dial.

sions have been carefully arranged to combine attractiveness with ease of operation. The Lotus all-brass condensers for attachment to these dials are already well known, they having been adopted in several instances in the construction of *The Wireless World* receivers. Reaction and differential reaction condensers, together with Lotus valve holders, H.F. chokes, and intervalve transformers are among the smaller components.

Garnett Whiteley and Co., Ltd., Lotus Works, Mill Lane, Old Swan, Liverpool.

LUNMET (LONDON METAL WAREHOUSES). (222)

Metal stampings of interest to the radio manufacturer, together with aerial wire and the "Lunmet" insulated terminal, are the principal items of interest to be found at this stand.

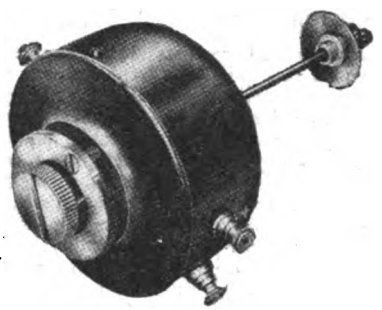
London Metal Warehouses, Ltd., Hill Street, Pocock Street, Blackfriars, London, S.E.1.

M.P.A. (165)

The M.P.A. Mark VI loud speaker unit is a well-made device, and has several refinements not usually found in a low-priced instrument. For instance, it is provided with an extra terminal for earthing the case, a useful feature in dealing with wandering H.F. currents in a self-contained receiver. It is included in the new M.P.A. Plaque loud speaker, which has been completely redesigned since last season. A new low-priced cabinet cone loud speaker, also energised by this movement, has been introduced.

The All-Electric Three is a combination of neutralised H.F. amplifier, detector, and pentode output valve. It conforms with the I.E.E. regulations, and is designed to work on A.C. mains. Provision is made for gramophone reproduction.

Another set that should be popular is the Screen-Grid Transportable Four, which is entirely self-contained except for a connection to A.C. mains.



New M.P.A. unit.

An all-electric radio-gramophone (also for A.C. supply) is also produced. This includes a four-valve receiver (screen-grid H.F. amplifier), internal rotatable frame aerial, and electric turntable motor.

Components manufactured by this firm include a range of power transformers, heavy-duty smoothing chokes (mention

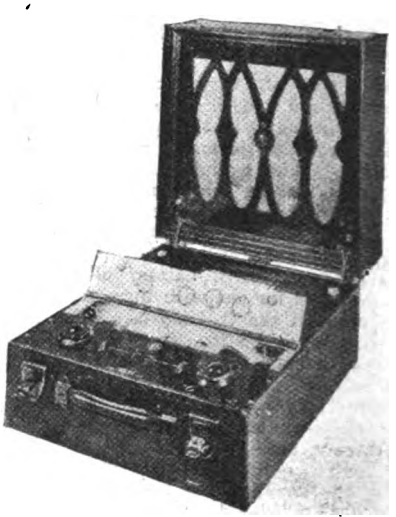
M.P.A. Self-contained set.

should be made of Type SM/600, de signed to carry 600 milliamperes) and change-over switches, cam-operated and of low capacity. A universal eliminator, providing H.T., grid bias, and raw A.C. at low tension for A.C. valves is also manufactured, as well as a more ambitious model for public address work.

M.P.A. Wireless, Ltd., High Rd., Chiswick, London, W.4.

McMICHAEL. (161 & 163)

McMichael products include portable and transportable receivers, mains-driven sets, a kit of parts, as well as various components such as coils, chokes and switches. First in relative importance is the Super Range Portable Four, a now well-known suit-case portable which, while incorporating only one H.F. stage, is not handicapped in its performance against its five-valve competitors. This model now forms the basis of a new set of the cabinet type, which consists of similar equipment, but is housed in a polished walnut cabinet with oxidised copper fittings. This instrument is offered on the reputation of its predecessor. It is a high-quality, long-range outfit. Tuning is simple, and is by geared thumb dial, and can almost be regarded as single-dial control. The price, including royalties and all equipment, is 26 guineas. Assuming that the



The McMichael Super Range Portable Four.

continuance to market a model is an endorsement of its merit, there can be little doubt as to the high performance of the Super-Screened Four-Portable. By the use of two screened valve H.F. stages the aim has been to make available the maximum number of stations. A high degree of L.F. magnification is provided by a pentode. A special system of single-dial tuning is fitted by which the

McMichael New Super Range Four.

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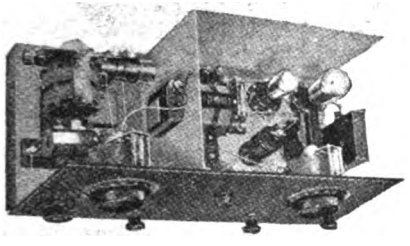
Stand-to-Stand Report.—
several tuned circuits are used to their best advantage as an alternative to the simple process, often impairing performance, of ganging. The cabinet is of figured walnut, and behind the grille is a Celestion loud speaker. The price is 35 guineas. Mains-operated sets are represented by the Mains-Driven Screen-Dimic Three. This is a receiver of the cabinet type for use with an elevated aerial. It has an H.F. stage, and its circuit is orthodox, necessitating the use of two tuning dials. Incidentally, this is probably one of the few mains sets capable of operation on the ultra short wavelengths of 15m. upwards. Another receiver of unique cabinet design is the Portable Four Table Model. Embodying the receiver chassis of the standard Super Range Model, a modified layout provides for a sloping operating panel, while the loud speaker is arranged as a vertical grille forming the upper part of a desk-shaped cabinet.

A kit of parts is available for the home constructor for building a three-valve set. It is of simple design with screen-grid H.F. stage with a choke-fed anode and tuned grid detector circuit. Two sets



The McMichael Screened Three—a kit set for the home constructor.

of wave-range coils are included, the circuit changes being made by simple switching. Detection is by leaky grid condenser, and reaction is provided. The L.F. stage is transformer-coupled, the loud speaker terminals being in the anode lead of the output valve. Volume control is by variable resistance in the filament circuit of the H.F. valve. Most ingenious is the circuit detail by which the gramophone pick-up is introduced without the need for switching, while the necessary negative grid bias is provided by the grid cell associated with the H.F. stage. The kit of parts costs less than £9, includes high-grade components, and is readily assembled. By the use of interchangeable coils, the tuning range can be adapted to cover wavelengths from 15 to 10,000 metres.

L. McMichael, Ltd., Danes Inn House. 265, Strand, London, W.C.2.

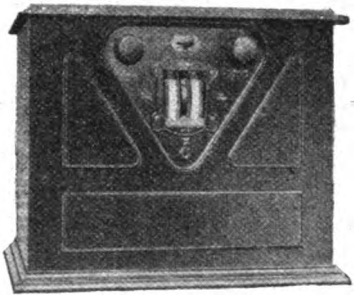
MAGNUM (BURNE-JONES & CO.). (125)

Two- and three-valve mains receivers shown here are new Magnum products. The two-valve model priced at £16 10s. is a detector L.F. set using Mazda valves. Its two vernier-controlled dials are for aerial tuning and reaction, while, in addition, on the front of the instrument is a two-range switch and jack for gramophone pick-up. The three-valve model is more elaborately constructed and is tuned by means of double thumb dials. There is a volume control in ad-

Magnum A.C. mains receiver.

dition to reaction. The additional valve is an H.F. amplifier, and is the Mazda screen-grid. Dimensions 16in. × 15in. × 14in. There is a five-valve Magnum transportable, priced at 18 guineas. It has two-dial control, the tuning panel also carrying a wave-change switch and break jack for external loud speaker. A suit-case model is also available of similar circuit arrangement. H.T. current consumption is given as only 7 mA. for these receivers. An all-electric gramophone reproducer, known as the "Magnagram," is also manufactured, the loud speaker fitted being of the moving-coil type. The "Magnagram" is fitted with a self-contained frame aerial, and provision is made for radio reception. Tuning is by single dial, while, in addition, there are both reaction and volume controls.

Burne-Jones are well known as manufacturers of components, and, although no definitely new lines are shown, the range includes H.F. chokes, a wavetrap, screening boxes, six-pin coils and bases, single vertical screens, neutralising condenser, fixed condensers, calibrated rheo-



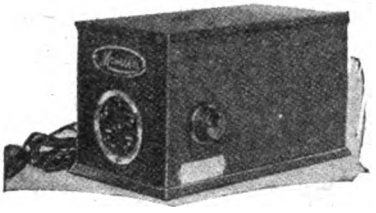
Three-valve Magnum receiver for use with A.C. supply.

stats, grid leaks, panel brackets, a continuously variable high resistance for use as a volume control, valve holders for four-pin and five-pin valves, L.F. chokes, a wavemeter and wavemeter coils, reaction and differential condensers, switches, and a gramophone pick-up. Prices are competitive.

Burne-Jones and Co., Ltd., 288-296, Borough High Street, London, S.E.1.

MAINTEN. (226)

The chief products of this company are H.T. eliminators for D.C. and A.C. mains. In all models great care has been exercised with regard to prevention of shock; for instance, where plugs and sockets are used—and this form of connection is to be found in practically every unit—the sockets are well recessed into insulating bushes. All units are contained within an earthed metal case, so that the requirements of lighting companies and the specification of the I.E.E. are complied with. There are six D.C. eliminators, called D.C.M.1 to D.C.M.6. In the smaller models the whole of the space around the components is filled with wax, which militates against broken contacts and dislodged components should the unit



Eliminator for A.C. mains, manufactured by Mainten.

be roughly handled. The prices of the three models referred to are from 30s. to £2 7s. 6d., and fixed tappings only are provided. The D.C.M. types 4, 5 and 6 have variable control of screen and detector voltages, and a liberal current for power-valve or pentode output is available. No common potential divider is used in any eliminator marketed by this firm, the necessary voltage dropping being effected by series resistances.

A current-limiting device is included in the D.C.M. models, and even a short circuit of the output does not burn out the resistances or choke windings. A negative choke is used in each case, as its inclusion is found to be essential where the "neutral" conductor is positive. Of six A.C. units five employ rectifying valves, while a sixth contains a Westinghouse half-wave metal-oxide rectifier. The A.C.M.5 contains a Mullard D.U.2 full-wave rectifying valve, and, including royalty, sells at the moderate figure of £6 10s. complete. There is a variable tapping for screen voltage and two fixed tappings for the anode requirements of other valves, the total output being 20mA.

With the widespread interest in selectivity, due to the powerful transmission

Mainten D.C.M.5 eliminator.

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Stand-to-Stand Report.—from Brookman's Park, amateurs will be paying considerably more attention to high-frequency amplification, which, with modern valves, entails comprehensive metal screening; a full range of metal cabinets being shown by this company will thus be of considerable interest.

Mainten Manufacturing Co., Ltd., 126, *Portland Road, Hove.*

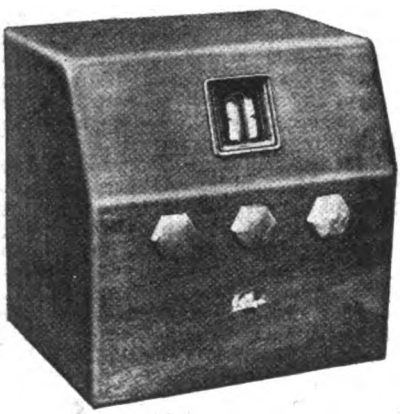
MANUFACTURERS' ACCESSORIES CO. (236)

As the name implies, this stand is principally devoted to a range of radio apparatus of interest to the retailer. H.T. and grid bias batteries are included bearing the trade name "Reliomac." Mains transformers, together with battery eliminators and chargers, and bearing the name "Maco", are also shown.

Manufacturers' Accessories Co. (1928), *Ltd.*, 85, *Great Eastern Street, London, E.C.2.*

MARCONIPHONE. (79-84)

It will probably be generally agreed that the new Marconiphone Model 56 Receiver is the star exhibit of this firm. Much can be said in favour of the principle of applying the major part of the total amplification provided *before* detection; here we have an outstanding example of this procedure. The set, with a total of five valves, includes three S.G.



Marconiphone Model 56 "3 H.F." receiver.

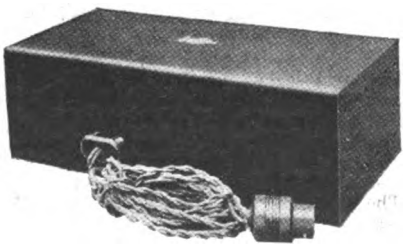
high-frequency amplifying stages, followed by an anode bend detector and a single resistance-coupled L.F. stage. Aerial coupling is "aperiodic," and thus there are four tuned circuits; these are ganged in pairs, and the two edgewise control drums are placed side by side so that they may be driven together as far as possible. As care has been taken to ensure that these pairs of condensers shall run together as closely as is practicable, the ideal of a single control is almost realised. Decoupling is extensively employed, and, while no attempt has been made to get the maximum obtainable gain from each stage, the overall H.F. amplification should be enormous, and one would expect that selectivity would be sufficient for the most difficult conditions, as a very loose aerial coupling could almost always be used. Incidentally, adjustment of this coupling provides the only form of volume control fitted (except detuning). It is stated that care has been taken to make it thoroughly effective, and one is forced to the conclusion that this form of signal intensity

Marconiphone Model 47 receiver.

regulation affords the best solution of the problem for a set of this kind, in which individual circuits are not particularly sharply tuned, and where a large (but not excessive) H.F. input to the detector should be maintained.

The set is housed in a dark walnut-coloured mahogany cabinet of a style that would perhaps be described as severe; the writer would prefer to say that there is no attempt at vulgar ornamentation, and that the general appearance is both pleasing and workmanlike. The front panel carries an escutcheon plate for the edgewise dials and three unobtrusive hexagonal bakelite knobs—coloured to match the woodwork—which control (reading from left to right) volume, waverange or gramophone, and filament switching. Types are made both for battery and A.C. mains supply; for the former 2-volt valves are standard, and for the latter the indirectly-heated type are used, with an ordinary 6-volt output valve. A pentode is obviously suitable for this set.

The Model 47 set is another interesting design. Built in a pressed all-metal cabinet, finished dark brown, it is typical of quite different practice, and is intended solely for A.C. mains operation. The circuit arrangement comprises a single H.F. stage (Marconi M.S.4 screen-grid valve), followed by an anode bend detector (indirectly-heated M.H.4. type). The two L.F. stages are resistance-coupled, the last valve being a new 4-volt directly-heated pattern with an output comparable to that of a P.625A. There is provision for a gramophone pick-up, and the two tuned circuits are controlled by a single knob with a balancing condenser across the aerial-grid coil. Volume control is by variation of aerial coupling. This receiver seems cheap at £24.

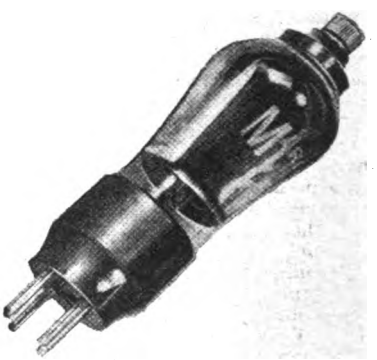


Marconiphone mains unit.

Model 39 receiver is similar in appearance to Model 56, but smaller and less ambitious in the matter of performance. Its circuit is an H.F.-det.-L.F. three-valve combination with reaction. Sockets provide for two alternative aerial couplings. There is space in the base of the cabinet for batteries or an A.C. mains unit. A pentode output valve may be used. The price is £21 complete for A.C. working.

Model 34 short-wave set, reviewed in these pages some time ago, is retained, but its price has been reduced to £22 10s., inclusive of valves. The Model 55 Portable now embodies an improved circuit arrangement.

There is a series of new mains units, among which one may instance the Model A.M.7, with a U.5 rectifying valve. This provides a maximum of 200 volts, with three other outputs variable in eight steps. It also provides raw A.C. for filaments or heaters at 0.8 volt, 4 volts, and 6 volts. The various units are of similar appearance, being housed in metal cases, of which the covers carry sockets corresponding with pins in the bases; when these covers are removed the supply circuit is automatically interrupted.



Marconi S.610 screen-grid valve.

The Marconiphone moving coil loud speaker has undergone considerable modification, and its suspension is now more conventional, as the central flexible spider support, mounted between base and apex of the cone, has been abandoned. The new cone is pressed from buckram, with the spider at the apex as an integral part. A ring of light woven material supports the other end. Prices now range from £4 10s. upwards. There is a new reed-driven cone, in a mahogany cabinet, selling at £3.

No attempt will be made to present a description of this season's Marconi valves, of which there is a very complete series in battery (2-, 4-, and 6-volt) and A.C. patterns, with both direct and indirect heating; also power rectifiers.

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Stand-to-Stand Report.—

A new gramophone pick-up has just been introduced. This device is stated to give a sensibly uniform output between 25 and 4,500 cycles, and to provide a mean R.M.S. voltage of about 1.5. It should thus be amply sensitive to operate with a two-stage amplifier (or, of course, a detector converted into an amplifier followed by an output valve).

Marconiphone products, including the new pick-up, are demonstrated in the exhibition, and also at 13, Maclise Road, which is near by.

The Marconiphone Co., Ltd., 210-212, *Tottenham Court Road, London, W* 1.

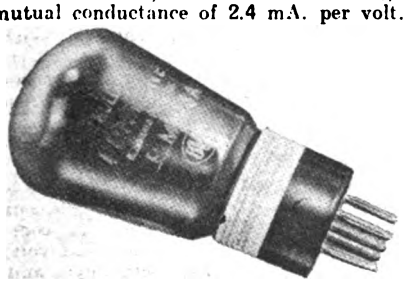
MULLARD. (58, 117 & 134-137)

In view of the widespread interest in all-mains A.C. receivers, probably the most attractive exhibits among the new components are the indirectly heated A.C. valves. There is an A.C. screened valve—

The Mullard indirectly heated screen-grid valve—the S.4V.

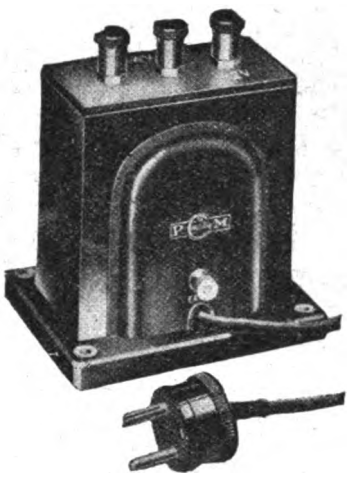
known as the S.4V—having an amplification factor of 1,000 and an A.C. resistance of 1.33 megohms. With a low-loss tuned anode or tuned grid interstage coupling, a single-stage gain of the order of about 100 times should be obtained. A step-down H.F. transformer is theoretically correct for maximum amplification, but as a tuned anode (or tuned grid) circuit which represents a 1 to 1 transformer is used, having many fewer turns on the primary than the optimum value, the selectivity should be considerably better than with a tuned anode circuit and an S.G. valve having an A.C. resistance of, say, 250,000 ohms.

The 354V valve has an A.C. resistance of 14,000 ohms and an amplification factor of 35, giving a mutual conductance of 2.5 mA. per volt. It is suitable for H.F., detector, or 1st L.F. positions, and will handle a grid swing of 8 or 9 volts. The 164V and the 154V are similar valves to the "D" valves, but with indirectly heated cathodes; the former has the high mutual conductance of 2.4 mA. per volt.



A new super-power pentode—the Mullard PM.24A.

The 104.V has an A.C. resistance of 2,850 ohms, an amplification factor of 10, and a remarkable mutual conductance of 3.5 mA. per volt; it is, of course, a power valve, and will handle about 20 volts grid swing. The heaters of these A.C. valves all consume 1 amp. at 4 volts.



Mullard filament transformer for A.C. valves.

Since last Olympia Exhibition a 6-volt S.G. valve and a 6-volt pentode have been added to their respective ranges, and there is now available a super-power pentode (the P.M.24A) for 4-volt accumulators or for direct A.C. filament heating, with a filament current of 0.275 amp. and

Resistance-capacity unit manufactured by Mullard.

a maximum anode voltage of 300. The auxiliary grid, which is brought out as a central pin in the base, should be connected to 200 volts H.T., when the power output will be enormous. It is probably better not to use the whole available grid bias, which appears to be nearly 60 volts, to prevent anode distortion, but even a fraction of this input would result in an output of sufficient amplitude to load the largest domestic loud speaker. The amplification factor of this output valve is 83, and the A.C. resistance 53,000 ohms.

The new P.M. filament transformer, selling at 32s. 6d., is primarily designed to supply the 4-volt heaters of the Mullard A.C. valves. The maximum output is 5 amps. at 4 volts. There are six models, with primaries suitable for the various A.C. supply voltages. The secondary winding has a centre-tap for cathode and earth connection, and the input frequency range is from 40 to 100 cycles. The combined P.M. grid leak and condenser holder is an innovation of interest; a special link is provided which allows the leak to be shunted across the condenser or to be connected to one side only. The price is 2s. 6d.

Besides a comprehensive range of receiving valves for 2-, 4-, or 6-volt accumulators, there will be retained in the 1930 programme the two Pure Music speakers, the "Permacore" transformer with nickel and silver winding, and the H.T. unit, as well as other 1929 components.

*Mullard Wireless Service Co., Ltd., Mullard House, Charing Cross Road, W.C.*2.

NEW LONDON ELECTRON WORKS. (67)

Aerial wire is principally shown at this stand. The simplest manner of erecting an aerial is probably with the aid of Electron wire, which is an insulated and stranded lead, or with Super Aerial, which has a more generous conductor. The earth mats shown form a convenient and reliable method of establishing the earth connection. They are conveniently fitted with 25ft. of earth wire. Durable wire, suitable for the running of extension leads, is available in various lengths from 50 to 500 feet. A topical idea is the introduction of 50ft. experimental aerials, which have been specially produced to provide improved selectivity when necessary for the separation of the Brookman's Park transmissions. There are various items at this stand of modest price.

*The New London Electron Works, Ltd., East Ham, London, E.*6.

NORMA (NORMAN HUNTLY). (235)

Norma components exhibited at this stand include variable condensers, switches and H.F. chokes. An aluminium plate log scale condenser of reliable con-

The Norma Five.

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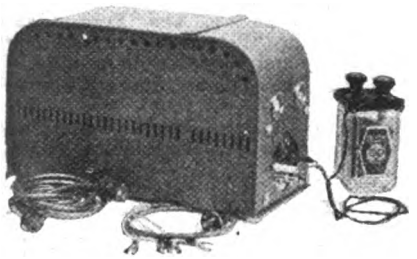
struction with one-hole fixing and ball race bearing is offered in a capacity of 0.0005 mfd. at the popular price of 4s. In addition there are two portable receivers, the Norma Five, which is available in a lacquered Chinese case at £16, and the Norma Screened Three, said to be capable of good foreign station reception and priced at £11 5s.

Norman Huntly, 35, Clerkenwell Green, London, E.C.1.



Oldham H.T. and L.T. Auto-Power unit.

OLDHAM. (66 & 70)

Called "power units," an entirely new range of devices is found at this stand by which H.T. and L.T. supply may be derived from A.C. supply mains. These units are not battery eliminators and do not possess the disadvantages commonly met with in such apparatus. Actually they are accumulator batteries which are automatically charged when disconnected from the receiving set. Three important advantages are thus obtained: (1) mains hum and the various complications associated with the mains earth are completely removed; (2) the output voltages are constant almost irrespective of the load—there are no voltage-dropping resistances; and (3) back-coupling, with its associated "motor-boating" is avoided, the unit having practically zero internal resistance. A range of these instruments is available to suit various requirements. There is an H.T. power unit as well as

The Oldham L.T. Auto-Power unit.

an L.T. power unit, each giving the advantages of a battery supply from a mains source. Should batteries be already to hand the rectifier, with its convenient automatic switch, is available. In every case the rectifier is of the Westinghouse type and an indicating lamp shows when the rectifier is in operation. A unit combining both L.T. and H.T. equipment is also produced. The most popular model is probably the H.T. Auto-Power Unit, which gives 120 volts, and its accumulator batteries may be loaded up to 100 mA. This is priced at £5 18s. 6d.

Popular-priced Oldham H.T. and L.T. batteries are shown in models to suit all needs. They are in glass containers and are supplied with metal frame and carrying handle. A range of unspillable accumulators in celluloid cases are available for portable set manufacturers and users.

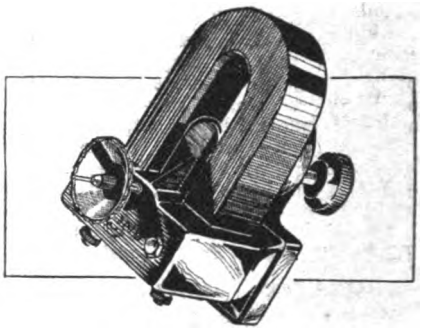
Oldham & Son, Ltd., Denton, Manchester.

ORMOND. (118 & 121)

The Ormond exhibit comprises essentially portable receivers, variable condensers for all purposes, loud speakers and loud speaker movements, together with a few minor components. A popular receiver selling at the particularly low price of £15 is the Ormond Five.

The Ormond five-valve portable.

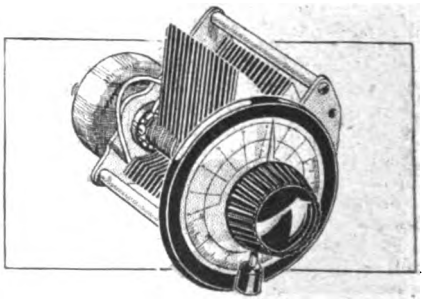
Triode valves are used throughout, and its two control dials provide for tuning and volume. Its loud speaker is of Ormond manufacture and is fitted with a four-pole adjustable unit. A transportable model, which also uses a five-valve arrangement, is offered at the same low price. Its controls comprise one dial tuning, a two-range switch and volume control. The loud speaker is similar to that fitted to the suit-case model. It is a well-finished set and is stated to be very economical in use. A recent addition to the Ormond range is a four-valve suit-case model using a screen-grid valve in the H.F. stage. A high degree of amplification combined with good selectivity results by the use of two tuning dials. The manufacturers state that both British and Continental stations may be easily received on both the broadcast and long wave bands. The loud speaker is of the four-pole Ormond type, and it should be pointed out that the component parts used in these receivers are of Ormond manufacture, a fact that is probably responsible for the popular prices at which



Ormond loud speaker unit.

they are offered. The Ormond Four suit-case model is priced £16 16s.

An outstanding component of the Exhibition is the Ormond four-pole adjustable loud speaker unit. A particularly large polarising magnet is used, and the working parts are completely encased in a well-finished bakelite cover. Ease of fixing is an obvious merit, as it can be readily attached to a back board through which the adjusting knob projects. The cone is readily mounted in a metal and felt washer fitting, and is then attached to the driving rod, easy adjustment being obtained by means of a chuck form of screw. This construction allows of instant removal when required. High quality of reproduction combined with sensitiveness and an ability to handle great volume without chatter are the merits claimed. The price is 12s. 6d. A metal chassis has also been produced to suit the four-pole Ormond unit. It is a strong aluminium pressing 11¼in. in diameter, and is provided with two brass spacing pillars to facilitate assembly. Entire absence of "drumminess" is a property claimed when using this chassis combined with a clear and crisp response and a full bass. The price is 7s. 6d. Complete loud speakers are also available, the model R55 being enclosed in a well-finished oak



Ormond condenser with the new "pointer" dial.

or mahogany cabinet which is offered at the low price of 50s. Making use of the four-pole unit is another model, which in an oak or mahogany cabinet bears the low price of 29s. 6d. Regardless of price,

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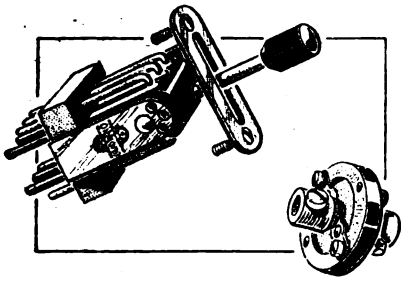
however, this loud speaker would appear to be a first-class instrument.

In addition to the extensive range of Ormond condensers, which are now so well known, is seen a small twin log scale model intended for the simultaneous tuning of two radio frequency circuits. Where space is limited this two-section condenser will be found particularly suited. The extremities of the moving vanes are connected to ensure correct spacing with rigidity. Ganged small log scale condensers have also been introduced. These are mounted by the "along the panel" method, making use of a small flexible coupling. This coupling, which is in the form of a bakelite ring on which are sprung two sockets mounted back to back, is obtainable separately. It provides a universal joint and obviates the necessity of strictly aligning the condenser spindles. A condenser fitted with a pointer dial is an entirely new development. This condenser is of exactly similar design to the standard Ormond small log scale condenser, but is constructed mainly of aluminium. The dial is a metal disc with a gold finish, carrying a scale of degrees.



Ormond key switch and condenser coupling.

The dial readings are shown by the pointer, the spindle of the condenser being controlled by a smaller knob. An upper knob provides a slow motion adjustment on friction action condensers. This pointer dial is not supplied separately as it can only be used with condensers having a modified spindle. The price of a friction control condenser complete with the new pointer dial and of capacity 0.0005 mfd. is 9s. 6d.

Push-pull and lever type switches of types which have many radio applications are among the smaller components. The lever type, which is well finished, is particularly suitable for carrying out the circuit changes met with in portable set construction, and in this respect the space it occupies is very limited. Of a low loss design, it may be used in H.F. as well as L.F. circuits. A three-contact push-pull switch has many uses, such as for wave changing in Hartley and similar circuits or for "on" and "off" in L.T. and H.T. battery leads. It can be mounted on a metal panel and insulated by means of the ebonite bush if necessary. This switch, which sells at 1s. 6d., is neat and compact and robustly made. It has both terminals and soldering tags.

The range of Ormond jacks has been adapted so that with the aid of a push-pull device they may be used as switches.

*The Ormond Engineering Co., Ltd., Ormond House, Rosebery Avenue, London, E.C.*1.

P. & R. (PETO & RADFORD). (108)

This stand is devoted to storage accumulators, both for L.T. and H.T. supply. A variety of different types are shown, in containers of glass, celluloid and "Dagenite"—a moulded material. An attractive model is the P.G.F., an inexpensive glass cell incorporating the well-known Peto & Radford feature of gravity floats, which indicate the state of charge. The 30-ampere hour cell costs 13s. 9d. A range of unspillable cells for portables include, in several instances, the advantage of gravity floats.

Peto & Radford trickle chargers are entirely new products. The A.C. model, which includes a metal rectifier, is suitable for recharging H.T. batteries up to 150 volts; it is fitted with a small lamp bulb which acts as a fuse and also shows when the charger is in operation. The D.C. model is fitted with a milliammeter and costs 29s. 9d., as compared with 49s. 9d. for the A.C. instrument. The fact that such chargers as these are available makes the H.T. accumulator battery a very attractive proposition to those with an electric supply.

*Peto & Radford, 50, Grosvenor Gardens, London, S.W.*1.

PANDONA. (225)

The all-electric radio-gramophone embodies a five-valve frame-aerial receiver with two aperiodic H.F. stages, and is fitted with a Marconiphone moving coil loud speaker, electric turntable motor, and B.T.H. pick-up. Models for A.C. or D.C. mains are available; it can also be supplied in a form suitable for working with an M-L converter and 12-volt battery.

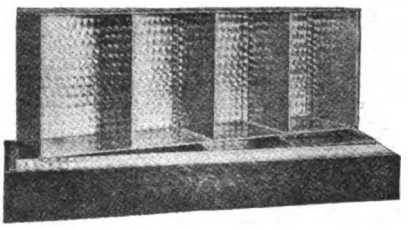
A similar instrument is fitted with an Air-Chrome loud speaker and a spring motor; it also includes a built-in frame aerial.

The "Pentode Two" model, with Air-Chrome loud speaker, is supplied for A.C., D.C., or battery feed.

Pandona, Ltd., 87-89, Edmund Street, Birmingham.

PAREX (E. PAROUSSI). (206)

Exhibits on this stand include a number of special screening boxes and screens, among which is included a metal



Parex metal cabinet.

cabinet intended for the "Kilo-Mag Four" or "Record III" receivers. This is constructed of sheet aluminium with an engine-turned finish, and special care seems to have been taken to ensure that the seams shall be adequately closed. Coils and H.F. transformers for the "Kilo-Mag Four" are also shown.

A wavetrap, consisting of a section-wound litz coil with a semi-variable tuning condenser, the whole mounted in a screening case, is another new product.

Among other exhibits are a cone-type loud speaker with a built-in clock and a horizontal type of valve holder, specially suitable for screen-grid valves.

*E. Paroussi, 10, Featherstone Buildings, London, W.C.*1.

PARMEKO (PARTRIDGE & MEE). (98)

Mains transformers for all radio purposes are produced by Partridge & Mee. Representative specimens are shown at the stand, and reference to their list shows quotations for some twenty different types. These are analysed into four classes: (1) for valve rectification; (2) for Westinghouse metal rectifiers; (3) for Igranic Elkon rectifiers, and (4) high voltage output transformers suitable for moving-coil loud speaker requirements. All transformers are built with substantial aluminium frames, with ample separation between the various windings. A range of generous smoothing chokes is produced for use with the various transformers. An interesting form of smoothing choke is one that has been introduced for use in the setting up of rectified L.T. supply. Two models are available, rated to pass, respectively, 2 and 3 amperes. An interesting component is the Universal Output Transformer, intended for use with moving-coil loud speakers. It is only by carefully regulating the primary and secondary windings that good quality is obtained, and this is achieved with this Universal transformer by arranging the primary as six sections and the secondary as five sections. A multiplicity of ratios can be obtained by series and parallel connections, which are obtained by means of adjustable strap connectors. An inter-valve transformer with high primary inductance and a ratio of 1 to 2 is a new component.

A.C. battery eliminators have long been produced by Partridge & Mee, and there is a range of five types at prices from £4 15s. to £16 10s. At the former price is a junior model with valve rectifier giving 26 mA. at 120 volts, together with three intermediate tappings of approximately 50, 70 and 100 volts. A generous model, the A.C.4, employs two rectifying valves of the RHI type, so that its output of 100 mA. at 500 volts is suitable for the most generous of amplifiers. Combined H.T. and L.T. eliminators are also shown.

*Partridge and Mee, Ltd., 74, New Oxford Street, London, W.C.*1.

PEERLESS (BEDFORD ELECTRICAL & RADIO CO.). (45)

A screen-grid portable set is one of the principal exhibits of this firm. The layout is of fairly orthodox design, apparatus being mounted in a hide suit-case, of which the lid serves to accommodate the loud speaker and frame aerial. The two variable condensers are

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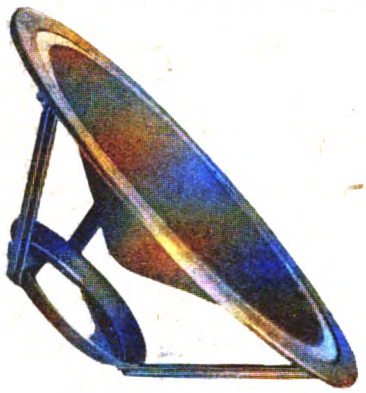
"ganged," and thus there is but a single tuning control.

A new cone loud speaker chassis of all-

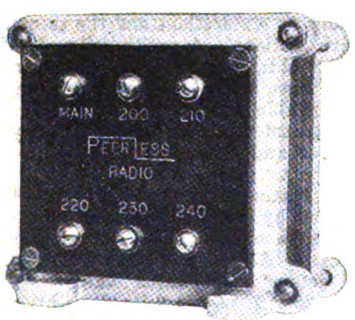


Peerless cone chassis.

metal construction—duralumin is actually used—is another new product. The diaphragm is lightly suspended by a leather ring, and matters are so arranged that Ormond, Blue Spot, or Brown units may be fitted with a minimum of trouble. Indeed, it should not be difficult to adapt this chassis to any type of drive mechanism. The price is only 7s. 6d.

A range of small power transformers, for all standard main voltages and periodicities, is also on show. These components are designed for H.T. outputs from 25 to 75 mA., and also have separate L.T secondary windings for supplying directly or indirectly heated valves.

The Bedford Electrical & Radio Co., Ltd., 22, *Campbell Road, Bedford.*



Bedford Electrical Co.'s power transformer.

PERFECTAVOX. (114)

Perfectavox radio-gramophones not only possess outstanding merit by way of finish and design, but are unique as to the technical details of the equipment used. It is stated that the output amplifier fitted in the Standard and Screened Grid models is capable of delivering a power output of 6 watts without overloading, thus revealing the use of generous output valves. The output amplifier in fact is a push-pull arrangement, using the adequate bias of 100 volts. Apart from a volume control which follows the detector, there is a device known as a "brilliance control," which is in effect an adjustable filter, and therefore can be usefully employed for the removal of surface noise when using the electrical pick-up. An adjustable filter of this type is probably to be preferred to a fixed filter arranged to obliterate the upper frequencies. The smaller sets, as would be expected, use grid rectification, whilst the larger sets, which are preceded by a high-frequency amplifier, use the anode bend detector. Attention is drawn in the descriptive pamphlet to the amplification which is provided and the precautions necessary to prevent overloading. In this respect provision is made for reducing the aerial input by means of a small series connected condenser. Reaction is provided, but it is understood that its use is rarely required. The frame aerial is unique and is built within the lid, but is capable of rotation within the frame.

Perfectavox, Ltd., Alexandra Works, High Street, Yeadon, Nr. Leeds.

Peto Scott Rover portable.

PETO SCOTT (42-44)

The Rover Portable is a cleanly designed self-contained set on fairly conventional lines. Its circuit arrangement includes two aperiodic H.F. stages, detector with reaction, and two transformer-coupled L.F. stages. An external loud speaker may be used, and provision is made for connecting a gramophone pick-up. There is a turntable base, and the valves are gripped between shock-absorbing strips of sponge rubber. The price is 16 guineas.

The "Hotel Orchestra" is an electric gramophone with three-stage amplifier and B.T.H. motor and pick-up. It is designed to provide sufficient volume for a large public room, and can be supplied either for A.C. or D.C. mains. There is ample space for storing records in the cabinet.

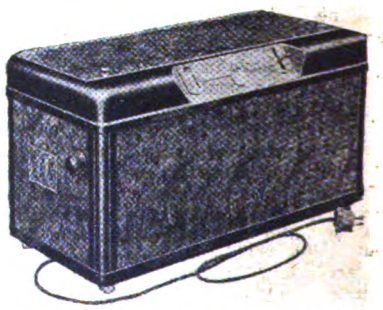
The Peto Scott Radio Gramophone comprises a Philips two-valve set housed in a large console cabinet fitted with spring-driven turntable, B.T.H. pick-up, and Air-Chrome loud speaker. Operated in conjunction with an external or indoor aerial, this inexpensive outfit should be eminently satisfactory for average requirements.

This firm specialises in the supply of complete receivers, sets of parts, or commercial kit sets, either for cash or deferred payments.

*The Peto Scott Co., Ltd., 77, City Road, London, E.C.*1.

PHILIPS. (169 & 170)

British built Philips receivers are an outstanding feature of the Exhibition. While Philips have exhibited in previous years, their receiving sets have been excluded from stands in view of their foreign manufacture. The "All Electric" receiver, type 2511, although only recently available on this market must be regarded as the forerunner of mains operated sets designed for easy operation and with an external appearance suited to the home surroundings. It is worth while studying in detail the many interesting points to be gleaned from a close examination of this set. Firstly, the cabinet is built up by the fitting of bakelite panels on to a pressed metal frame. All corners are rounded, the external finish is durable and the appearance attractive without being decorative. A single lever switch moves from the "off" position through the two wave ranges and then to the position for using a gramophone pick-up. Only when the switch is in the "off" position can the lid of the cabinet be opened. Likewise, lock and key are provided which prevents the switch being moved from the "off" position and until unlocked the set can be neither operated nor opened, while when the lid is lifted the interior is entirely "dead." When switched on a pilot lamp illuminates the transparent drum of the tuning scale. Conveniently placed on the right-hand side is a single tuning knob which actuates the ganged tuning condensers through a reduction gear. In a corresponding position on the left-hand side of the cabinet is a volume control, which it is believed is associated with the H.F. stages. Two screened valves of the indirectly heated type (S4V) are used in the set followed by an indirectly heated leaky grid detector (154V).



The Philips "All Electric" receiver, type 2511.

The output valve is a directly heated power pentode (PM24A), while the rectifier employs a special full-wave valve (type 2506) with an emitter resembling

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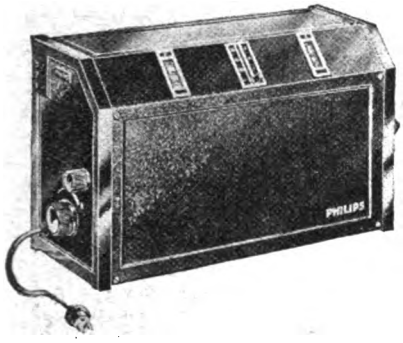
the cathode of an indirectly heated valve. All valves are screened from one another and the various units are contained in screening compartments. Two outputs are available, one suitable for the usual high resistance cone loud speaker and the other is regulated through the output transformer to suit the low resistance Philips moving coil loud speaker. When using a gramophone pick-up an external volume control is necessary indicating that the control fitted to the set precedes the detector. Remarkable range getting properties are claimed. Complete with valves the price is £37 10s.



Philips three-valve "All Electric" receiver.

Another interesting set, type 2514, is one using a three-valve circuit which again operates entirely from A.C. mains. Its circuit is that of an indirectly heated screen grid and detector followed by a pentode output. It covers both wave ranges, and terminals are provided for a pick-up. It has one knob tuning, an edgewise indicating scale and volume control. With the Philips loud speaker, type 2007, which has been specially designed to suit the receiver, it forms a simple and compact trouble-free outfit, and is priced at £23, complete with valves.

A less expensive model, type 2515, is a mains operated two-valve set with a special detector valve and followed by a pentode. Both wave ranges are covered and provision is made for the use of a pick-up. It is easy to operate and entirely meets the requirements of the average listener, and the price is £12 10s. complete.

Those seeking a commercially built short-wave receiver will be interested in the Philips set type 2802 which, with the aid of six interchangeable coils, covers a wave range of 10/2,400 metres. This is a battery operated set and is fitted with a screen-grid H.F. stage, leaky grid reacting detector, L.F. stage and pentode output. Only with the most distant stations are the four valves used, and a switch is provided to cut out one of the L.F. stages.

Battery operated sets include a three-valve receiver which is very similar to the type 2514 referred to above, but with the omission of the mains equipment.

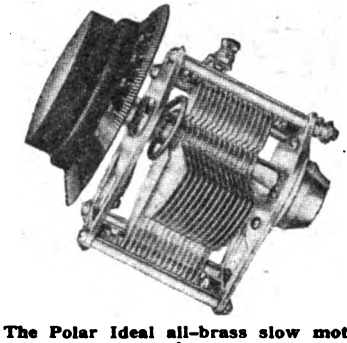
Space will not permit detailed reference to the Philips H.T. supply units. They deliver both H.T. and grid biasing potentials and are claimed to be suitable for use with all circuit systems free from hum, while conforming to the most exacting requirements with regard to the use of electric supply current for domestic purposes. In the A.C. models the valve type of rectifier is adopted.

There is also to be seen an extensive range of battery charging equipments for the recharging of H.T. and L.T. batteries from A.C. mains. The home models give charging rates from that of trickle charging up to 6 amperes. All these battery charging sets use arc rectifying valves. There are, in addition, many types suitable for charging station purposes and it is interesting to note that for a three phase model giving a D.C. output of 220 volts at 6 amps. an efficiency as high as 90 per cent. is claimed. As a guide to price, this model is quoted at £16 10s.

Philips Lamps, Ltd., Philips House, 145, Charing Cross Road, London, W.C.2.

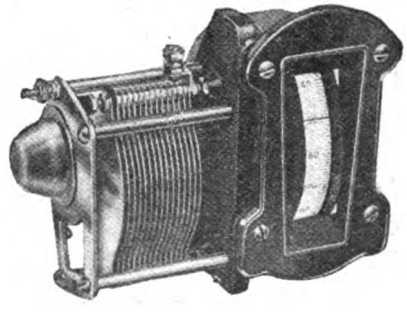
POLAR (WINGROVE & ROGERS). (128 & 133)

Polar condensers are the principal products of this company and one learns that Polar variable condensers are standardised by more than half of the set makers in this country who do not make their own. No fewer than eight different forms of variable condenser are

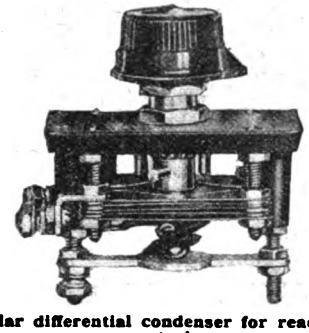


The Polar Ideal all-brass slow motion condenser.

exhibited. Readers are well acquainted with the popular and inexpensive all-brass condenser which is styled "Type No. 3" and has been adopted in a number of *The Wireless World* receivers. It is electrically efficient, has one-hole fixing and pig-tail connector, has steel ball-bearings and is reasonably compact. Another model is fitted with slow-motion movement actuated through a hollow spindle, so that unlike many slow-motion condensers complications are not encountered when securing it to the panel. This is the "Ideal" model and the 0.005 mfd. size is 12s. 6d. The slow-motion knob is 2in. in diameter and the fast motion is by the 3in. dial. The reduction ratio is 30 to 1. Examination revealed a particularly smooth action. An entirely new product is the Polar drum control condenser which incorporates both fast and slow motion and is controlled by two 3in. knurled drums. The neat ivorine scale with well finished bakelite escutcheon



Polar condenser with the new drum control.



Polar differential condenser for reaction control.

produce an attractive appearance. It is supplied for either right- or left-hand mounting, while double and triple condensers of this type are also available. Of interest among the smaller condensers is the "Q.J." model, which is an air dielectric condenser of compact dimensions and is intended essentially for reaction control. It has a slow-motion action and is supplied with either knob and pointer or knob and dial. The Polar differential condenser, also intended for reaction purposes, should prove a popular component. It has a bakelite frame, brass vanes and an insulating dielectric. Other components to be seen at the stand include coil units, various H.F chokes, the Polar fixed potentiometer and the "Claricone" cabinet loud speaker.

Wingrove and Rogers (Polar), Ltd., Arundel Chambers, 188-189, Strand, London, W.C.2.

PORTADYNE (WHITTINGHAM, SMITH & CO.). (113)

A series of portable sets are exhibited. The "Portadyne Screened-Grid" receiver, as its name implies, contains a screen-grid amplifier, followed by a detector and two triode L.F. amplifiers. Special attention has been paid to quality of reproduction, and a Brown cone loud speaker and baffle are included. The retail price is 22 guineas, in solid leather attaché case.

The "Super-Five" portable, selling at the popular price of 19 guineas, contains the same L.F. amplifier and loud speaker as the screen-grid set. A transportable set is also available.

Whittingham, Smith & Co., "Portadyne" Works, Chase Estate, Park Royal, N.W

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Stand-to-Stand Report.—

PYE. (160 & 162)

The new receiver, No. 460, is intended for battery operation, but, at the same time, the requirements of those with a

Pye No. 460 receiver.

D.C. supply have been borne in mind (A.C. mains users are catered for by other Pye models). This set includes a double-wound aerial coupling, completely insulated from the filaments, so that the aerial and earth circuit is not in connection with the source of supply. It embodies an S.G. high-frequency amplifier, anode bend detector, and two L.F. stages, resistance- and transformer-coupled. The H.F. valve is a Mazda 2-volt type, which is capable of affording an extremely high magnification.

A new type of edgewise control is fitted, with dials calibrated directly in wavelengths. A gramophone pick-up may be used. The cabinet is of dark walnut, with the high finish usually associated with Pye receivers.

Pye mains transformer.

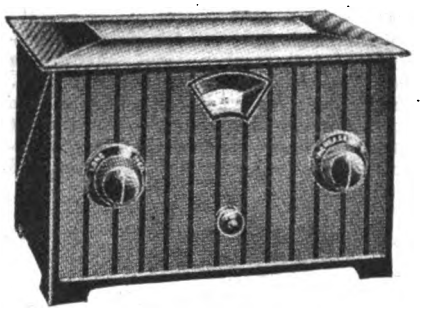
A new type of L.F. transformer has a shroud made of a special alloy which, it is claimed, prevents induction effects between its windings and other windings carrying A.C. current; in a mains-operated set this is a not uncommon source of trouble. The transformer has a step-up ratio of 3.3 : 1.

To replace the various output transformers previously manufactured, a universal device has been introduced. This provides for ratios of 1 : 1, 1.8 : 1, and 6 : 1. A similar component for pentode valves is available.

For use as a volume control resistance across the primary of an L.F. transformer, or for any other purpose where a very small current has to be carried, a variable non-inductive resistance has been produced. This is priced at 4s.

New patterns of valve holders, apparently with excellent electrical properties and of extreme compactness, have been introduced to replace earlier models.

For use in the construction of the more ambitious type of A.C. mains set the Pye "Silent Power" transformer should find a ready application. Intended to work with Westinghouse metal rectifiers, it provides, in addition to H.T. voltage, low-voltage outputs for indirectly heated valves, 6-volt output valves, and for loud



R.I. Two-valve receiver.

speaker field supply through a metal rectifier and floating battery or special smoothing circuit. A total output wattage up to 60 is provided for in the design.

The No. 687 heavy-duty choke has six sectional windings, the ends of which are led out to plug sockets mounted on an insulating board.

Transformers for various types of metal rectifiers are also exhibited.

Pye Radio, Ltd., Paris House, Oxford Circus, London, W.1.

R.I. (122-124)

Many readers will welcome an opportunity of examining the Transportable Screened Grid Three, a receiver recently reviewed in this journal, in which an exceptional high standard of efficiency is attained.

The firm is staging an historical exhibit of L.F. transformers (in the design of which they have specialised for many years), starting with an early specimen made by Latour. There is also a show of early H.F. apparatus.

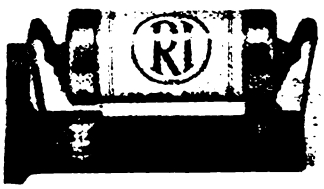
A useful new component is a special power transformer designed for use with the Westinghouse metal rectifier and approved officially by the makers of that device. It sells at 21s., and is part of a range of power transformers for various purposes.

The new R.I. two-valve receiver is of interesting design, if only because it is mounted in an all bakelite moulded case with pins protruding through the base. The standard model is for a battery feed, but these pins are so arranged that by placing the set on a special eliminator

R.I. mains transformer.

base pedestal, either for A.C. or D.C. supply, it is automatically converted for mains operation. A pentode output valve is fitted.

A series of wire-wound non-reactive resistances has been produced, with values up to 0.5 megohm. A range of power resistances dissipating up to 10 watts is also available.



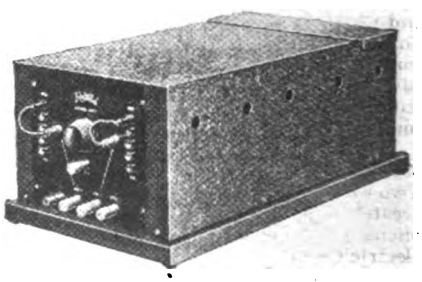
R.I. wire-wound resistance.

The R.I. Portable Testing Set, though not a new season's product, merits the attention of those whose business is concerned with the testing and location of faults in wireless apparatus. Two high-grade meters are mounted on the panel.

Radio Instruments, Ltd., 12a, Hyde Street, New Oxford Street, London, W.C.1.

RADIELLE. (2)

The Radielle Company have recently come to the fore in the manufacture of



Radielle model R.K. eliminator for A.C. supply.

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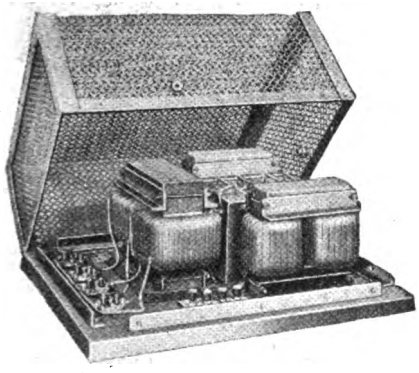
Stand-to-Stand Report.—

mains equipment. At their stand, therefore, one finds various mains transformers and smoothing chokes to suit the requirements of the home constructor as well as numerous power units. The R.K. model for use with A.C. supply incorporates a Westinghouse rectifier and, in addition to the maximum voltage output, there are two variable outputs produced by tapping points and wander leads along resistances. A continuously variable potential is also provided for use with screened valves, and is therefore, in effect, a volume control for the set it feeds.

A heavy duty A.C. mains equipment which is shown has been specially produced for electrically reproducing gramo-



Radielle heavy-duty rectifier.

phones where a considerable power output is required. The output is 200 mA. at 400 volts, together with an A.C. voltage suitable for the filaments of the output valves of the receiver. Four R.H.I. rectifying valves are used.

The Radielle Co., Ltd., 18A, *Haverstock Hill, Chalk Farm, London, N.W.3.*

RADIO GRAMOPHONE DEVELOPMENT CO. (292)

The instrument produced by the Radio Gramophone Development Co. under this trade name is a good example of the best modern practice in the design and construction of apparatus of the class suggested by the firm's title. Several different types are produced, and the D.C. model will be described, as it has been examined in detail. The circuit comprises two H.F. stages (one tuned and one aperiodic), followed by a diode rectifier and two L.F. stages, the last being push-pull. Pre- and post-detection intensity controls are fitted in order to provide for full regulation of volume both for radio and gramophone reproduction. Decoupling devices are applied extensively. A moving coil loud speaker is fitted in the base of the large and handsome cabinet. Two tuned H.F. stages can be fitted where greater range is necessary. The gramophone turntable is driven by a B.T.-H. electric motor.

This instrument is fitted with a pick-up evolved by its manufacturers, in which coil damping is applied to the reed, which works on a knife edge, against which it is held in position by a rubber spring. This promising component is sold separately at the price of £3, complete with arm.

A neatly constructed power amplifier for public address or gramophone repeater work is also shown. This instrument has a bank of six output valves with grids in parallel and each anode connected to its own output transformer for feeding a separate loud speaker.

Power chokes and transformers designed for heavy duty, manufactured by Messrs. William Bayliss and Co., of Sheepcote Street, Birmingham, are exhibited on this stand, as are the "M-L" rotary converters and transformers for power supply.

Radio Gramophone Development Co., 7, St. Peter's Place, Broad Street, Birmingham.

RADIO SERVICE. (204)

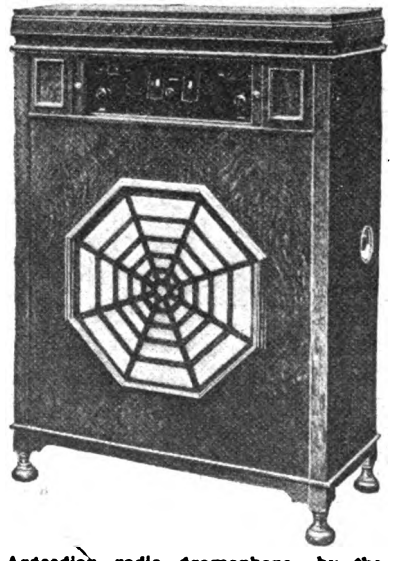
Although no apparatus is actually exhibited at this stand, the service which is represented is of no less interest. The organisation is devoted entirely to the supply and maintenance of high- and low-tension batteries, and the delivery service extends to within a radius of twelve miles of Charing Cross.

Radio Service (London), Ltd., 105, *Torriano Avenue, Camden Town, London, N.W.5.*

READY RADIO. (93)

The principal exhibit on this stand is a selectivity unit to be known as "Susie"—a device designed to provide existing sets with the necessary selectivity for the regional scheme. There are means included for earthing the aerial, and two models are available, one for the medium broadcast band and the other for the longer wavelengths.

Another product is the "dynamic Reproducer" selling at £6, in which it is claimed that a particularly good response is obtained to the higher frequencies.



Argeedian radio gramophone, by the Radio Gramophone Development Co.

For those who are protagonists of the parallel-feed circuit for screen-grid valves the H.F. choke being shown should appeal.

Ready Radio, Ltd., 159, *Borough High Street, S.E.1.*

RED DIAMOND (JEWEL PEN CO.). (267)

The chief industry of the Jewel Pen Company is turned and machined ebonite parts. Of these there are being exhibited a large selection of well-finished aerial and earth connectors, plug-in terminals, flex connectors, lead-in tubes, and H.F. choke formers. There are wander plugs, coil mounts, and terminal strips with terminals mounted and the usual engraved markings. A very complete range of plain and threaded bushes is exhibited and should be useful when wooden panels are employed.

Jewel Pen Co., Ltd., 21-22, *Great Sutton Street, E.C.1.*

Rees-Mace portable superheterodyne.

REES-MACE. (105)

The writer does not profess to have seen the whole of the Olympia Exhibition—he has so far had quite enough to do in that part of it with which he is directly concerned—but he will be surprised to find a lighter and more compact four-valve portable than the Rees-Mace "Gnome." Weighing some 20lb., and measuring, when closed, 13½in. by 11in. by 6in., this little set must surely represent the limit in compactness. It includes a screen-grid H.F. amplifier with tuned coupling, followed by a grid circuit detector and two L.F. amplifiers. There are two tuning dials and reaction control. The price of the complete receiver is 19 guineas.

Many readers will remember that a Rees-Mace portable with two tuned H.F. stages was recently reviewed in this journal; this interesting model is also exhibited, together with a seven-valve self-contained superheterodyne.

Rees-Mace Manufacturing Co., Ltd., 39a, *Welbeck Street, London, W.1.*

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REDFERN'S. (46)

This firm are showing ebonite in various forms suitable for wireless work. "Ebonart" panels are retained, and a cheaper grade, sold under the trade name of "Bulwark," has been introduced.

Ribbed coil formers, in diameters from 2in. up to 4in. and with either 6 or 8 ribs, are also exhibited. At the suggestion of contributors to this journal, a special deep-rib former has recently been introduced, in order to facilitate the construction of section-wound coils of high efficiency approaching as nearly as need be to the ideal specification. These are also useful in the construction of H.F. transformers, for which the method of winding primary turns sandwiched between secondary sections is becoming increasingly popular; properly executed, it is almost as effective as the overwinding method requiring spacer strips, which is hardly practicable commercially.

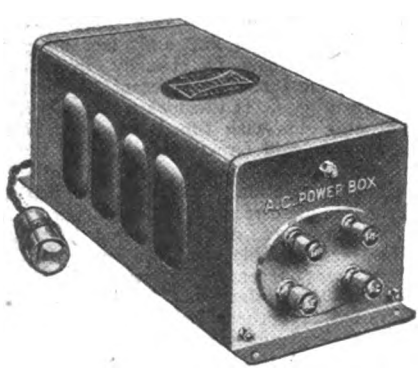
Redfern's Rubber Works, Ltd., Dawson Street, Hyde, Cheshire.

REGENTONE (REGENT RADIO SUPPLY CO.). (16, 17, 18)

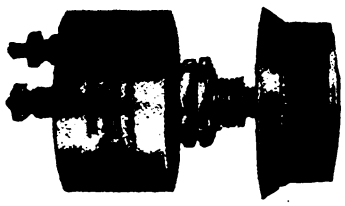
Apart from a complete range of H.T. eliminators for all conceivable requirements (in A.C. models, Westinghouse metal rectifiers are fitted as standard), this firm is showing a number of components for use in the construction of all-electric sets and eliminators.

The Regentone Power Box comprises a power transformer, with an extra L.T. winding delivering current at 4 volts for the heaters of A.C. valves, and a Westinghouse rectifier. The whole is mounted in a neat and compact metal box with ventilating slots. The output of this unit may be applied direct to a receiver including the necessary smoothing circuits, or a Regentone Filter Compact—another new product—may be interposed. These two units in conjunction make up a complete eliminator delivering H.T. up to 180 volts at normal load.

The need for comparatively critical adjustment of screening grid voltage is responsible for an increasing demand for variable resistances working over a wide range of ohmic values. To meet this demand, and also for other purposes, such as volume control, a new variable resistance, called the Regentstat, has been introduced. This component, supplied in a form suitable for panel mounting, has a rated range of from 250 ohms to 4 megohms, and is stated to be capable of dissipating 10 watts.



Regentone A.C. power box.



Regentstat variable resistance.

A range of power transformers and smoothing chokes are also exhibited, together with a neat three-valve A.C. receiver, built in a pedestal cabinet having the appearance of an ordinary occasional table.

Regent Radio Supply Co., 21, Bartlett's Buildings, Holborn Circus, London, E.C.4.

REPRODUCTION. (55)

A new type "Rhapsody Twin" portable Radio-Gramophone is exhibited for the first time. This compact instrument measures only 9in. × 15¼in. × 16in., and includes a turntable and spring motor. A volume control, operative on both radio and gramophone reproduction, is fitted.

Various models, both battery- and mains-operated, of the "Rhapsody Twin" radio gramophones are exhibited. Demonstrations are given in Room Q.

Reproduction, Ltd., 5, 6, 7, Dysart Street, Wilson Street, E.C.2.

Rolls-Caydon "Phantom Regional."

ROLLS-CAYDON. (106)

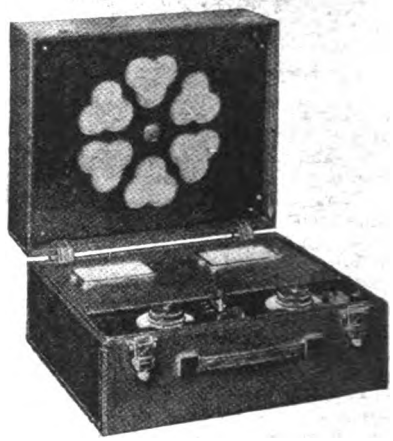
One of the most interesting of the many portable sets exhibited by this firm is the "Phantom Regional." The circuit is a four-valve combination of two S.G. high-frequency stages, detector, and a pentode output. It is mounted in a real hide crocodile-grained suit-case, and is equipped with an effective form of volume control. Double-capacity Hellesen H.T. batteries are fitted, and the loud speaker is of the new Celestion type, with a 14in. diaphragm.

The "Super Ranger Screened Four" is a rather more conventional arrangement of H.F. amplifier, detector, and two L.F. stages. It is also housed in a suit-case type of container and is fitted with a new Celestion loud speaker. An upright model of the so-called "transportable" type is also manufactured.

Rolls-Caydon Sales, 77, Rochester Row, Victoria Street, London, S.W.1.

ROYAL RADIO. (12)

An entirely new portable is seen at this stand. Its circuit comprises a screen-grid stage of H.F. followed by detector and two L.F. stages. The screening, which is concealed, is generously carried out, and good performance is claimed for the set as regards its range-getting properties, selectivity and quality of reproduction. The two tuning dials being small give a neat appearance to the control panel.



The Royal portable.

There is a reaction control as well as a two-range switch with mid-off position. Current consumption is less than 9 mA., and the L.T. accumulator has the generous capacity of 25 ampere hours. The loud speaker is of the four-pole balanced armature type coupled to a freely mounted cone diaphragm. The price is £18 18s.

Another interesting receiver is the Royal Radio-Gramophone, which is designed for operation entirely from A.C. mains. For radio reception the circuit is one of three valves, using a screen-grid H.F. amplifier. It is intended for use with an elevated outside aerial, a condition that is generally appreciated. The tuning controls are of the edgewise drum type, and the volume control is arranged to act with both radio or gramophone reproduction. The price is £47 5s. A modified model is available for use with D.C. supply.

Royal Radio Co., 4-5, Dorset Mews North, Upper Gloucester Place, London, N.W.1.

SELECTORS. (102 & 104)

This firm manufacture portable sets principally, and specimens of each of

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their productions is on view. The "Cabinet" model includes many refinements not usually fitted, such as an accumulator capacity meter and provision for charging the accumulator *in situ* from

Selector suit-case portable.

the electric light mains. It embodies a four-valve circuit, including a screen-grid H.F. amplifier, and has two tuning controls.

A large and handsome radio gramophone, with many refinements, and including double turntables, is also exhibited.

Selectors, Ltd., 206-7, *Bedford Avenue, Slough Trading Estate, Slough, Bucks.*

SEL-EZI. (205)

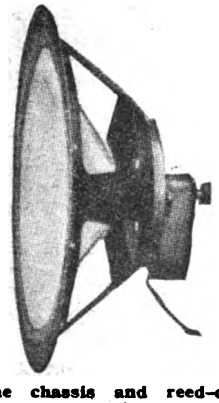
The activities of this firm are devoted to the wholesale distribution of wireless apparatus, and a representative assortment of standard products are exhibited.

Sel-Ezi Wireless Supply Co., Ltd., 6, *Greek Street, London, W.*1.

SELFRIDGE. (208-210)

The Wireless Department of this store is represented on these stands, and helpful advice is given to the public as to the choice of radio receivers most suitable to their needs. A considerable amount of apparatus of various kinds is exhibited.

*Selfridge and Co., Ltd., Oxford Street, London, W.*1.

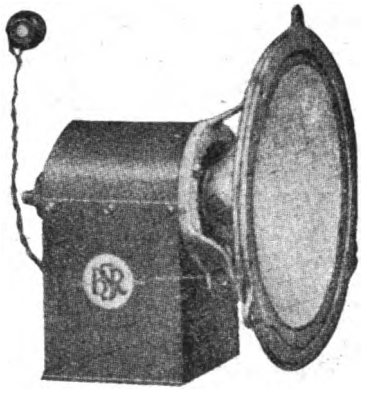


Baker cone chassis and reed-driven movement.

SELHURST (A. BAKER). (23)

A notable addition to the present comprehensive range of moving coil loud speakers is the super-power model which it is claimed has an extremely wide frequency response. A dynamo steel magnet system is employed, with a field winding of copper wire weighing 10lb. There is a centring device giving free parallel movement for about ¼in., and the sensitivity is such that a quite unambitious amplifier will give a sufficiency of volume. The speaker is finished in crystalline enamel and polished aluminium. The 6-volt accumulator model retails at £5 15s., and that for D.C. mains at £5 17s. 6d. The A.C. mains model, at £8 5s., consumes 1 amp. at 9 volts, and includes Westinghouse metal rectifier, transformer and smoothing equipment. Another A.C. mains speaker at £9 consumes 2 amps. at 9 volts, and contains the same full equipment. A new chassis with floating cone for loud speaker units can now be supplied with either 7in. or 9in. cones with flexible leather suspension designed to fit well-known reed-driven units. The prices are 12s. and 14s respectively.

A dynamic speaker, known as the "Super 1930 Moving Coil," sells at the popular price of £4 17s. 6d. for the 6-volt unit and £7 10s. for the A.C. unit, which consumes 1 amp. at 9 volts. Both models include a speech transformer. A permanent magnet moving coil speaker is being shown at £6 5s., and contains a



Super-power moving coil speaker by Baker (Selhurst).

cross-shaped magnet. For those who like to construct their own moving coil speakers a perusal of the well-illustrated catalogue issued by this company will reveal the existence of many essential components such as centring devices, oiled-silk and rubber suspensions and diaphragm paper. Advice concerning suitable amplifier design is given, and as suitable quality receivers the "Everyman-Four" and "Megavox-Three" are described.

A. Baker, 89, *Selhurst Road, South Norwood, S.E.*25.

SIEMENS. (69 & 71)

In addition to the well-known H.T. and L.T. Siemens batteries, suitable for all radio purposes, reference might be made to the cells of the rechargeable type. These are actually sealed wet cells, so that an economical source of H.T. or L.T. current is produced, and where charging is carried out by the addition of water to the crystals supplied. For the small H.T. cells, which are in glass containers, it is claimed that the electrolyte, being in the form of a jelly, is unspillable and does not evaporate. Creeping, normally a serious failing, is likewise avoided. The spring connections which are fitted obviate the need for soldering. Generous amalgamation of the zinc prevents deterioration when out of use. The cells, which vary in price between 8d. and 1s., are easily recharged. The L.T. battery is intended for use in country districts where it is inconvenient to use an accumulator. The economical discharge rate is 0.25 ampere, with a maximum rate of 0.5 ampere.

New form of Siemens cell suitable for biasing an H.F. stage. A special low-voltage cell has been introduced for use in "Wireless World" receivers in order to avoid an excessive bias potential.

Siemens accumulators in glass boxes are also exhibited. The containers are ribbed, and hold the plates securely in position without the use of separators. A good and somewhat unusual feature is that of a glass top with grease-filled cups to the terminal lugs. Of interest to the home constructor is the special fixing tab which now forms the base of the single grid cells such as are used for the biasing of an H.F. amplifier. Attention is drawn to a special cell which has been introduced to conform to the specification requiring a cell of 0.9 volts given in the design of *Wireless World* receivers. This cell is almost essential for the correct biasing of the screen-grid valve.

Moving coil testing instruments are also shown. A useful instrument by which most of the measurements associated with a radio receiver can be made has six ranges, viz. : 3, 15 and 150 volts, 7.5, 75 and 750 mA. When used as a voltmeter the instrument has a resistance of 150 ohms per volt. A useful booklet, entitled "Inside Knowledge," on the correct use of radio batteries is obtainable at the stand.

*Siemens Bros. and Co., Ltd., Caxton House, Westminster, London, S.W.*1.

SIMPLICON (WILLIAMS & MOFFAT). (229)

The drive mechanism of all Simplicon variable condensers has been modified this year by the fitting of a non-spin device.

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Stand-to-Stand Report.—which prevents spinning of the slow-motion knob when the direct control is in operation. There is a general improvement in details.

The Duplex type, intended for semi-gang tuning of two circuits, has been modified by placing the direct drive edgewise drums side-by-side in the central escutcheon plate slots, while the outside drums control the slow-motion gear.

As for the standard models, these have been improved by knurling the bevel face of the dial, to give a better grip for direct drive.

A compact 0.0005 mfd. tuning condenser with bakelised sheet interleaving has been produced. It is observed that the outer vanes are made of stouter sheet metal than are the others; thus extra protection is afforded to them.

There is a range of small reaction condensers with both direct and slow-motion drive and brass plates. These are made in capacities of 0.0001 mfd., 0.00015 mfd., and 0.0002 mfd.

The new Simplicon edgewise dial has a form of gearing slightly differing from that of its predecessor. It is so arranged that it can be mounted either on the right- or left-hand side of the tuning condenser. There is also a new drum dial with knob drive. Prices of all Simplicon condensers have been reduced this season.

Messrs. Green and Falconbridge, of Coventry, are exhibiting on this stand a kit of parts for the home construction of a twin-diaphragm loud speaker. This comprises a steel frame over which fabric membranes are stretched. All parts are included, and full instructions are provided.

Williams and Moffat, Ltd., Ladypool Road, Sparkbrook, Birmingham.

SIX-SIXTY. (288)

A series of new valves, with indirectly heated cathodes for A.C. mains, is introduced. The S.S. .4 G.P.A.C. is a valve suitable for neutralised H.F. amplification or as a detector, and has an amplification factor of 35, and a slope of 2.4 mA. per volt. The S.S. .4 Det.A.C. is an A.C. valve having characteristics very similar to those of the steep slope "D" detectors.

Six-Sixty ball-bearing turntable for portable sets.

The power valve in this series has an amplification factor of 10 and a mutual conductance of 3.3 mA. per volt. The indirectly heated S.G. valve has an A.C. resistance of 1,330,000 ohms and an amplification factor of 1,000.

A new super-power pentode, the filament of which can safely be heated with A.C., has a maximum anode voltage of 300, but the auxiliary grid voltage should not exceed 200. The valve is capable of giving an enormous power output.

There is a representative range of battery-operated valves with 2-, 4- and 6-volt filaments. To facilitate the orientation of a frame aerial in a portable set, a well-built turntable 7in. in diameter with peripheral ball race is shown, and sells at 6s. A reed-driven cone assembly,

The Six-Sixty reed unit with cone.

with arrangement for one-hole fixing and having a felt damping ring, is available at 22s. 6d. It is specially suitable for portable sets.

Six-Sixty Radio Co., 122, *Charing Cross Road, W.C.2.*

SOVEREIGN (J. R. WIRELESS CO.), (266)

Stand No. 266 is devoted to a display of the "Sovereign" products, including the H.F. choke used in the Six-Sixty Kit set recently reviewed in these pages. This component has a rated inductance of 175 millihenrys and a self-capacity of 5 micro-microfarads.

The Sovereign rheostat is made in maximum resistance values of 6, 15, 30 and 50 ohms. The last-mentioned should be useful for inserting in the filament circuit of a 4- or 6-volt low-consumption H.F. valve for volume control purposes. These rheostats are specified for the Mullard S.G.P. receiver.

A dual-range aerial tuning coil is also produced; this component is fitted with a fixed reaction coil, and is intended for use in circuit arrangements where regeneration is controlled by a variable condenser. Other components are a wave-trap, six-pin coil base, and slow-motion dials.

The J.R. Wireless Co., 6-8, *Rosebery Avenue, London, E.C.*

SPARTA (FULLER ACCUMULATOR CO.). (75)

The Fuller Accumulator Company has just introduced a series of unspillable cells for use in portable receivers. The electrolyte is in the form of a jelly. A glass wool pad is fitted in the base of the cell and an ebonite sheet is mounted over the plates, with the result that leakage should be impossible. It is intended that the cells shall be capable of operation in any position. They are shown in capacities up to 40 ampere hours (at a 20-hour discharge rating).

Ten-volt accumulator H.T. batteries, in multi-compartment glass containers, are manufactured in two sizes. Type M.H.G. is rated at 3,000 milliampere-hours, and the larger batteries, type D.M.H.G., at 6,500 milliampere-hours. These five-cell units are priced, respectively, at 5s. and 7s. 6d., and are supplied in a dry-charged condition, requiring only the addition of acid to put them into operation.

A large assortment of other batteries, in glass, ebonite and celluloid containers, are available for inspection, including the well-known Fuller Block cell.

The Fuller Accumulator Co., Ltd., Woodland Works, Chadwell Heath, Essex.

SUNCO (SUN ELECTRICAL CO.). (250 & 251)

The wireless department of this well-known electrical firm are wholesale agents for radio products of all kinds, and a display of products of the principal manufacturers is made.

Sun Electrical Co., Ltd., 118-120, *Charing Cross Road, London, W.C.*

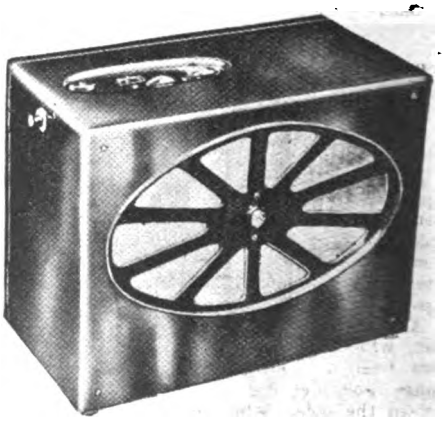
SYLVEX. (231)

Materials for constructing loud speaker diaphragms form the principal part of this exhibit. After having procured a suitable drive unit, one often experiences difficulty in obtaining a suitable material of the required thickness and weight wherewith to make the diaphragm. In addition to a Sylvex card marked out and printed for making a cone diaphragm, sheet pertinax is obtainable cut to size. This thin pertinax sheet is light, stiff and durable. Many home-constructed loud speakers are of poor appearance owing to the fact that the diaphragm is exposed to view behind the grille. A tinsel fabric is therefore available made of metallised cotton, which, it is stated, will not lose its brilliancy.

Sylvex, Ltd., 144, *Theobald's Road, London, W.C.1.*

SYMPHONY. (129 & 130)

Radio-gramophones and a portable set are the chief exhibits. The battery-operated radio-gramophones, types G.R. or G.R.R., are priced at 40 and 45 guineas respectively. For radio reproduction a five-valve set is pressed into service containing two H.F. triodes linked by aperiodic couplings and there are two



Symphony portable set.

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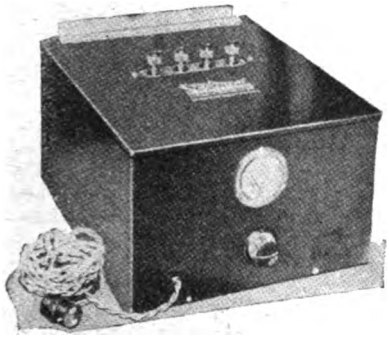
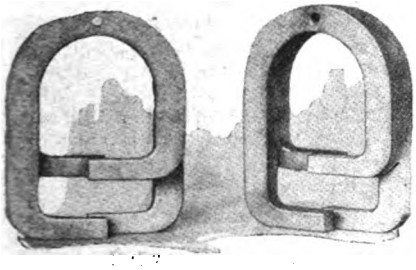
Stand-to-Stand Report.—transformer-coupled L.F. stages. Orientation of the frame aerial wound with stranded conductor is effected by a knob on the panel; there are separate frames for the two wave-bands. Reaction is capacity controlled and a non-spillable L.T. accumulator is provided. The all-electric *de luxe* model sells at £125, and



The Symphony eliminator provides both H.T. and L.T. from the mains.

is fitted with an electric motor and automatic stop and switch. All the valves have indirectly heated filaments, including the S.G. valve, around the circuits of which good screening has been arranged. There is a moving coil loud speaker, capable of giving sufficient volume for dance halls, and the whole equipment is contained within an extremely handsome cabinet, with side compartments for record storage.

Symphony Gramophone & Radio Co., Ltd., Axtell House, 23-24, Warwick Street, Regent Street, W.1.



Balanced-armature magnet system by Swift Levick.

SWIFT LEVICK. (240)

Permanent magnets find an extensive application in radio technique. This company is exhibiting all kinds of magnets—cast, bent, and stamped in cobalt and tungsten steels as are used in loud speakers, telephones, gramophone pick-ups, and relays.

An interesting balanced-armature magnet, which is available to manufacturers, has been so designed that the maximum possible flux density exists between the poles, which can only be done by the continuity of the magnetic circuit in magnet steel right up to the gap and without any joints whatever. The magnets in 35 per cent. cobalt steel will give a flux density on the gaps of about 8,000 lines per square cm.

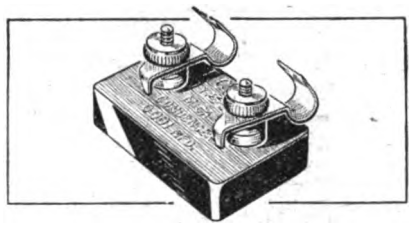
The new cross type magnet for moving-coil speakers is being shown. It consists essentially of a solid steel casting arranged with four outer limbs connected to a circular inner core. No soft iron plates or centre pegs are necessary for completing the magnetic circuit, as is the case with nearly all moving-coil permanent magnet systems. Joint leakage is eliminated, and the highest possible flux density in the gap is maintained. With this magnet gap, flux densities varying between 5,000 and 8,000 lines per square centimetre can be obtained. Cobalt steel is used—a steel which has an extremely great resistance to de-magnetisation.

In our forecast in last week's issue, the inscription under the illustration of the cross type permanent magnet for moving-coil speakers stated that this unit was available to home constructors. This is not the case, as the magnet can only be supplied to manufacturers.

Swift Levick & Sons, Ltd., Clarence Street Works, Sheffield.

T.C.C. (248)

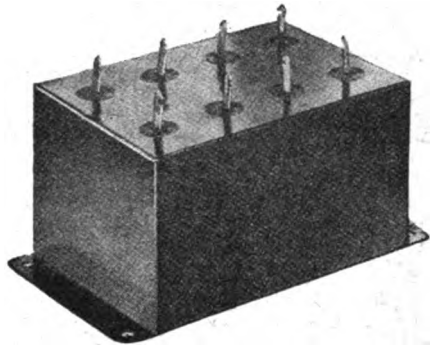
With nearly a quarter of a century's experience in condenser manufacture the dependability of this firm's products is a foregone conclusion. Fixed condensers for



T.C.C. mica condenser with grid leak clips.

every conceivable position in a radio receiver are to be seen on their stand. The well-known upright mica type of condenser, in a green case, has lately been reduced in price. For instance, capacities of 0.0001 mfd. to 0.0009 mfd. now sell at 1s. 6d., whilst 0.01 mfd. variety in mica is priced at 3s. There is now on the market a range of small flat moulded mica condensers with capacities of 0.0001 mfd. to 0.0009 mfd. at 1s. 3d. each, this price includes grid leak clips, and the capacity values are guaranteed to be accurate within 10 per cent. These small condensers have the following dimensions :—$1\frac{9}{16}$in. × 1in. × $\frac{5}{16}$in., and are tested to 500 volts D.C. to work at a peak voltage not to exceed 250. The same type of condenser in capacities from 0.001 to 0.01 mfd. can be supplied at a slightly higher price.

With high-frequency stage amplification of over 100 times, the question of power factor in by-pass condensers made of aluminium foil and paper is becoming of importance; it is therefore interesting to note that this company is setting itself



T.C.C. tapped condenser block for H.T. units.

the task of investigating the potentialities of non-inductively wound condensers in both metal and bakelite containers. For low-tension eliminators for filament heating the dry electrolytic condenser is essential. This component is available in a polarised type, with the following specifications, the capacities being measured at 50 cycles :—2,000 m.f.d., working voltage 12, selling at 15s.; 2,000+2,000 mfd., working voltage 12, selling at 27s. 6d., and a model specially suitable for transmitting valves with a capacity of 500 mfd. and a working voltage of 40, the selling price of which is £1. The maximum permissible leakage current in all cases is 10 mA.

Condensers used in mains units are often subjected to voltage surges, and it is therefore very advisable, in order to prevent breakdown, to see that the D.C. test voltages are considerably above the peak value of the supply. For this reason the 800-volt test 2 mfd. condenser, selling at 5s., should ensure an ample margin of safety when used in an eliminator.

Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, W.3.

TANNOY (TULSEMERE MFG. CO.). (276)

This company specialises in battery-substitute units. Two H.T. units con-

Tannoy units for deriving valve current from the mains (Tulsemere Mfg. Co.).

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Stand-to-Stand Report.—taining a full-wave electrolytic rectifying device are marketed. Type 12C, suitable for 2- or 3-valve sets, includes a potential divider, giving a variable voltage for each valve. Type 16C.H. gives a voltage output up to 160, and the maximum current is 100 mA. These two units, without transformer or rectifier, are suitable for D.C. mains. The L.T. supply unit consists of a metal-oxide trickle charger with a switch that throws the accumulator in circuit with the set or the charger at will.

Combined H.T. and L.T. mains units have been introduced, selling at £5 12s. 6d., £6 10s., and £8 10s.

Tulsemere Manufacturing Co., 1-7, *Dalton Street, West Norwood, S.E.27.*

TELSEN. (110)

The well-known Telsen "Radiogrand" transformers have been considerably improved in a number of details. Air spacing and sub-division of the windings is now employed, with the result that proportional amplification of the higher frequencies is increased. The core laminations are redesigned, and internal insulation has been improved. Detachable feet are now fitted, so the user has considerable latitude in the method of mounting.

The smaller "Ace" transformer, specially intended for portable sets, is retained.

Telsen Electric Co., Ltd., Miller Street, Birmingham.

TONEX. (265)

A reacting two-range tuning unit, the "Tonatuna," is the principal product of Tonex. A wave-change switch is contained within the instrument by which the long-wave section becomes short-circuited Connecting up is simplified by reducing the number of leads to only five, including aerial grid and reaction circuit.

Other Tonex products include the completely screened dual range coil known as the "Univox," an H.F. choke totally enclosed in an octagonal moulding, as well as a valve holder in which the connectors have serrated faces, thus ensuring clean contact.

The Tonex Co., Tonex Works, Walker Street, Blackpool, Lancs.

TRELLEBORG. (231)

The various applications of Trelleborgs ebonite are illustrated on this stand by a comprehensive display of turned and machined component parts and accessories.

Panels in polished black, imitation mahogany, and wavy finish are also exhibited.

Trelleborg Ebonite Works, Ltd., Union Place, Wells Street, London, W.1.

TRIX (ERIC J. LEVER). (211 & 212)

The new radio-gramophone produced by this firm is designed for operation on an A.C. supply. It includes a receiver comprising a detector and two L.F. stages with indirectly heated valves, and is intended for operation with an external aerial. A volume-control device in the L.F. amplifier is operative on both radio and gramophone reproduction. The loud speaker, consisting of a 6ft. folded logarithmic horn and a balanced armature unit, is built into the lower part of the containing cabinet. The gramophone turntable is rotated by a spring motor.

Another model is on similar lines, but the turntable and associated gear are arranged as an easily detachable unit, which can be connected to the amplifier through a flexible lead, thus allowing records to be changed in a different room or at any convenient point in the same room. This would appear to be a useful innovation.

The receiver included in the radio-gramophone described above is also supplied as an ordinary table model A.C. set. Choke-filter output is provided and a pick-up jack is fitted.

The Trix 5-valve portable which includes the unusual feature of a special socket arrangement whereby an eliminator may be connected to the set in a few moments, at the same time automatically disconnecting the internal H.T. battery, is also on show.

Trix radio-gramophone.

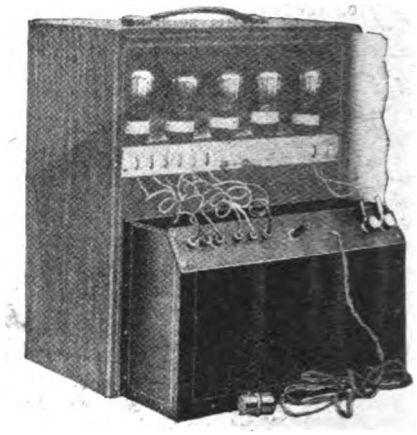
Among new components introduced this season are 5-pin rigid valve holders for A.C. valves with sockets insulated by sleeves. There is also a promising H.F. choke with staggered windings, priced at 5s. 6d.

Eric J Lever (Trix), Ltd., 8-9, *Clerkenwell Green, London, E.C.1.*

TRUPHONIC. (167)

Owing to the popularity of batteryless receivers, interest will be focussed upon a mains "trickle" unit built essentially to fit the Truphonic Melo-Set, but which can be used with other receivers to convert them to all-mains operation. As the name implies, the unit contains a trickle-charger to maintain the L.C. accumulator at its proper voltage, together with an H.T. eliminator.

Owing to the increase in voltage available for amplification, the use of the "Mains-Trickle" unit with a portable set causes a marked improvement in reception,



Truphonic mains trickle unit.

both in range and volume, whilst it does not interfere with the use of the set with ordinary batteries if a lighting supply be not available. The price of the unit is £9 10s.

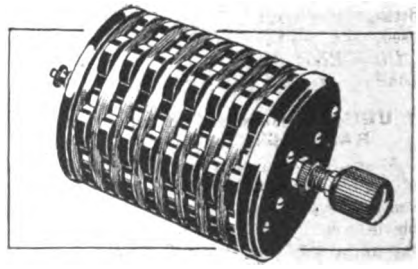
The "Dista-Set" is a four-valve suit-case portable receiver with a single stage of screen-grid amplification. The frame aerial and inter-stage inductances are both tuned by separate condensers, and extreme care has been taken with the screening. This set sells at £21 complete.

The Truphonic suit-case five-valve portable, with two aperiodically coupled H.F. triodes, sells at 16 guineas and the Truphonion loud speaker at £3 10s.

Truphonic Radio, Ltd., Truphonic House, Hanover Park, Peckham, S.E.

TUNEWELL (TURNER & CO.). (95)

Turner & Co. exclusively manufacture coils, and in addition to all forms of standard plug-in coils there are specimens conforming to the requirements of published designs. The range includes a popular dual-range coil which carries



Tunewell two-range tune.

windings for both broadcast and long wavelengths, as well as a reaction coil, which is particularly suited to the simple construction of an inexpensive set. The

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Stand-to-Stand Report.—
home constructor will find at this stand a coil to meet every requirement.

Turner and Co., 54, Station Road, New Southgate, London, N.11.

ULTRA. (106)

Here, the principal exhibit is a new form of loud speaker known as the Ultra Air-Chrome. On a wooden frame, which is the largest of three models, measuring 18in. × 23in., is a tight linen diaphragm. A reed drive of the balanced armature type is attached at the centre, while a second and smaller diaphragm is arranged so that the convex faces of the two diaphragms face together and join at the point of attaching the drive. Variations due to temperature and climatic

The Ultra Air-Chrome portable.

conditions are avoided by suitably treating the linen. Prices are from £2 2s. to £4 4s. This form of loud speaker chassis is supplied in various forms of cabinets.

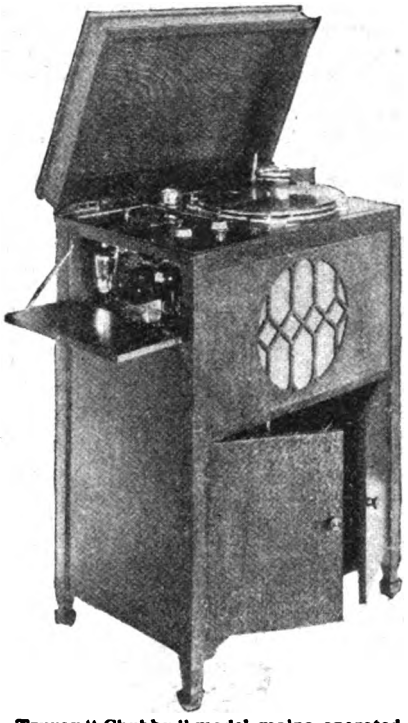
At this stand also is the Ultra Air-Chrome Five, a well-finished portable offered at the popular price of 16 guineas. It has two H.F. and two L.F. stages, covers both wave ranges, and is fitted with a local station rejector circuit. Its loud speaker is of the type described above. Tuning is by edged controlled drum with fine and coarse adjustment. The case is leatherette-covered and the fittings are oxidised. Osram valves are used, the output being the D.E.P. 215.

Ultra Electric, Ltd., 661, Harrow Road, London, N.W.10.

UNIVERSAL GRAMOPHONE & RADIO CO. (40, 41, & 100)

A speciality is made of loud speakers of the folded experimental horn type, and these as well as the Truvox gramophone are demonstrated in Room 1 on the main gallery. Artistic self-contained equipments for both radio and electrical gramophone reproduction, together with electric gramophones and loud speakers, are on view on this stand.

Universal Gramophone and Radio Co., Ltd., Ryland Road, Kentish Town, London, N.W.5.

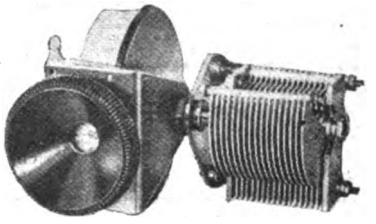


Truvox "Chubby" model mains-operated radio-gramophone.

UTILITY (WILKINS & WRIGHT). (115)

The combination of a drum edgewise dial and a knob drive as applied to variable condensers is not altogether new, but in the "Mite" drum condensers the details of design are distinctly unusual. These components, which are made for both right- and left-hand drive, are fitted with a knob having a hole in its centre, through which the drum scale is visible. Reduction gearing is effected by a friction drive between knob and drum. Fitting is by no means difficult, although a comparatively large hole must be cut in the panel to clear the knob. These condensers should have many applications where conventional patterns are unsuitable. They are fitted with internal phosphor-bronze springs, which ensure that good contact is made with the rotor without the necessity of a pigtail.

The Utility Micro-Dial, of the pattern fitted with a fixed aluminium scale with cursor, remains unchanged in essentials, but is supplied with a moulded bakelite back-plate which improves its appearance.



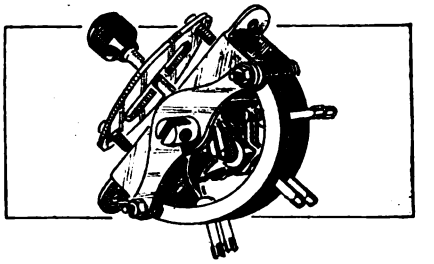
New Utility Edgewise Mite condenser.

"Mite" condensers, well known for their extreme compactness, are now produced in "ganged" pairs, the rotors being built on a common spindle. The same components are also supplied in the form of a differential condenser for reaction control circuits of the type in which it is desired to maintain a constant capacity between the detector anode and earth.

Another series of condensers with hollow spindles and reinforced end plates is also being produced. It is understood that these are to be arranged in such a way that the rotors of two or more units mounted together may be turned together. final balancing of the tuned circuits being effected by swinging individual stators, which will be capable of rotation through a few degrees. This is a development of prime importance, which will be carefully watched. Precise details are lacking at the moment of writing.

The Utility New Pattern Switch has been fitted with a modified form of contact arm, which seems to have effected a considerable improvement. The older type of low-capacity switch has been given a definite "off" position by introducing a kink into the swinging metal arc.

Wilkins and Wright, Ltd., Utility Works, Holyhead Road, Birmingham.



Improved Utility switch.

VARLEY. (154 & 159)

Varley products this year are particularly numerous, and in addition to an extensive range of components we find also all-electric receiving sets. There would appear to be no fewer than thirteen different forms of L.F. transformers, including all types of transformer intervalve couplings as well as output transformers to suit all conditions in the output stage.

Pentode Output Transformer.—D.C. resistance, 1,070 ohms. Primary inductance, 28 henrys with 20 mA. Maximum current, 30 mA. Ratio for high-resistance loud speakers 2¼-1, and for low-resistance speakers 45 to 1. This component would appear to be essential for the correct use of the pentode valve. Price £1 1s.

Pentode Output Choke.—Like the above transformer this also has a double ratio. D.C. resistance, 950 ohms. Inductance, 90 henrys at 15 mA. Combined ratios of 2 to 1 and 3 to 1. Price £1 1s.

Dual Low-frequency Choke.—This is an adaptable component in that by suit-

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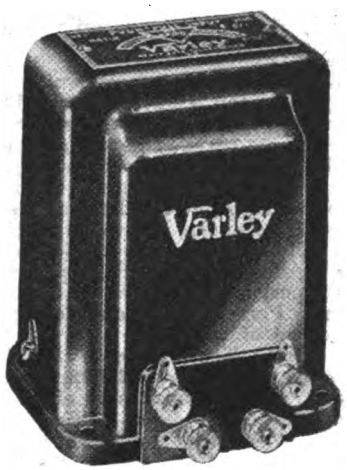
Stand-to-stand Report.—ably arranging the connections between its four terminals it will suit the requirements of a generous choke intervalve coupling, smoothing choke or heavy duty output choke. Inductance, 70 henrys at 10 mA., or 10 henrys at 70 mA. Maximum current, 140 mA. Price £1 1s.



Varley heavy duty push-pull input (intervalve) transformer.

Standard Low-frequency Choke.—Intended for use as an output filter or for smoothing in a mains eliminator. Inductance, 16 henrys at 100 mA. Maximum current, 140 mA. Price £1.

Heavy Duty L.F. Intervalve Transformer.—This is an entirely new component specially introduced to serve as an intervalve coupling between a small power valve and the output stage. Ratio, 5 to 1. Inductance, 44 henrys at 5 mA. Price £1 3s. 6d.

Output Transformer.—By providing a double ratio this transformer permits of the use of loud speakers of either high- or low-resistance windings. Ratios, 1 to 1 and 20 to 1. Maximum primary current, 30mA. Price £1 1s.

Push-pull Output Transformer.—Here again a double-ratio output is provided. Total primary inductance, 48 henrys at 1,000 cycles, no D.C. passing. Price £1 4s., including royalty.

Heavy Duty Push-pull Input Transformer.—This is an intervalve coupling which may suitably follow a small power valve. A new refinement is that the secondary is wound in two separate sections, making it possible to separately control the two output valves. Ratio, 2½ to 1. Price £1 5s., including royalty

Push-pull Output Choke.—Like the standard output choke, this has a double-ratio secondary to suit high- and low-resistance loud speakers. Primary inductance, 38 henrys at 1,000 cycles, no D.C. passing. Price £1 1s.

Constant Inductance Low-frequency Choke.—This is an important new component in which the inductance of 20 henrys remains reasonably constant when carrying up to 100 mA. Useful as an output choke or a smoothing choke in eliminator construction. Price £1 1s.

Ni-Core I L.F. Intervalve Transformer.—This new component follows the modern practice with regard to the use of high-permeability alloy in place of stalloy iron. It occupies less space than the corresponding intervalve transformer referred to above, and has a D.C. current-carrying capacity of 2.5 mA. Ratio, 4 to 1. Price £1.

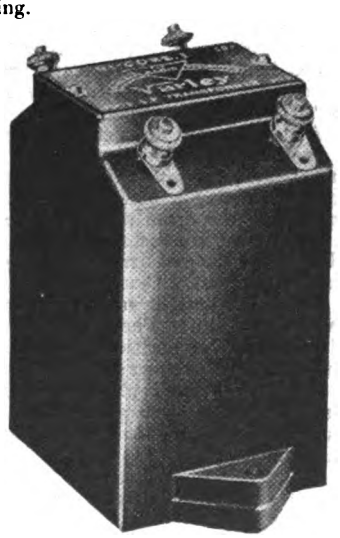
Ni-Core II L.F. Intervalve Transformer.—A compact model that has been produced to combine best performance with lowest possible price. Maximum D.C. current, 2 mA. Ratio, 4 to 1. Price 15s.

Low-tension Low-frequency Choke.—Intended for use in low-tension eliminators, and therefore possesses the low D.C. resistance of only 0.5 ohm. Current-carrying capacity, 3 amperes. Price £1 1s.

Mains Transformers.—A range of five models to suit Westinghouse and Elton metal rectifiers. Price £1 5s.

There are in addition numerous high-output mains transformers for use with both valve and metal rectifiers, and suit the requirements of the generous output stage using valves suitable for operating moving coil loud speakers. They are adequately protected and ventilated, and conform to I.E.E. recommendations.

A new and particularly useful component is a power potentiometer rated at 25 watts. The resistance units are interchangeable. This component has many applications in receiver and eliminator construction. The body is of moulded bakelite, and it is secured by one-hole fixing.

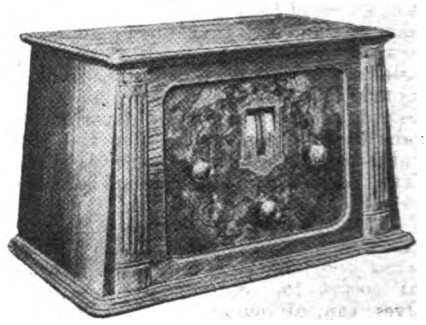


Varley L.F. transformer, the Ni-Core I.

There is a range of Varley mains receivers for use with either A.C. or D.C. supply. Tuning is by thumb dial. Provision is made for the use of a gramophone pick-up.

The well-known Varley gramophone pick-up embodies minor modifications as compared with last year's model. Its compound suspension arrangement reduces record wear to a minimum, gives a particularly uniform frequency response, and is entirely free from chatters. It is a particularly well-finished accessory, and the adaptor has been modified to suit H.M.V., Columbia, as well as Continental tone arms. The average mean generated potential is 0.2 volt. Price £1 17s. 6d. Resistance-capacity coupling units and H.F. chokes are also shown.

Varley, Kingsway House, 103, Kingsway, London, W.C.2.



The Varley mains-operated receiver.

VOLTRON. (217)

All brass-built variable condensers are the principal exhibit at this stand. A noteworthy point of construction is the entire insulation of both moving and fixed plates from the frame, thus rendering them particularly suited to the construction of mains receivers where there may be a difference of grid bias potential between condenser and screening. In addition, their suitability for use in D.C. mains receivers is appreciated by the removal of the danger of making contact with the supply.

The many components shown here include wire-wound resistances, complete resistance-coupled units, transformers of the high permeability core type in bakelite moulded cases, matched H.F. chokes for portable set construction, H.F. chokes, small fixed condensers, reaction and neutralising condensers, as well as a complete range of British-made Voltron valves.

Voltron Co., Ltd., 3, Queensway, Ponders End, Middlesex.

W.B. Four-pole unit.

W.B. (WHITELEY, BONEHAM & CO.). (86)

The W.B. four-pole balanced-armature loud speaker drive unit is built around a large cobalt steel permanent horseshoe

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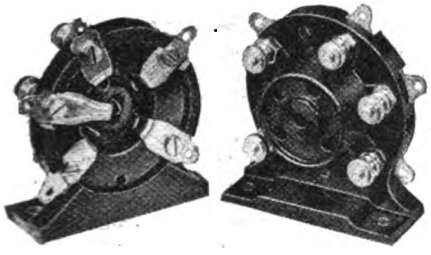
Stand-to-Stand Report.—

magnet. It is provided with an adjusting knob controlling the armature setting, and is supplied with conical washers for attaching the cone to the drive rod. This instrument is sold at 12s. 6d., a complete chassis and cone being available at 10s. 6d.

A workmanlike moving coil loud speaker of fairly conventional design is also exhibited. It should prove exceptionally sensitive, and is also economical, as the pot-winding magnet consumes but half an ampere from a six-volt accumulator. It is sold either as a kit of parts for home assembly or as a complete instrument. A model suitable for mains field excitation is also produced.

The new W.B. valve holders are of almost universal application. They can be mounted either horizontally or vertically, thus being suitable for screen-grid valves, and, though provided with a central socket for the new five-pin A.C. valves, can, of course, be used with battery-heated triodes or S.G. amplifiers.



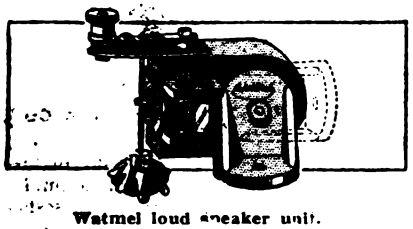
W.B. Universal valve-holders.

For this purpose it would be as well—but not essential—to remove the cathode socket; this operation presents no difficulty. It would be correct to describe the sockets as spring grips for the valve pins; their design is similar to that of those included in earlier models, and has already been commented upon favourably in this journal.

Whiteley, Boneham and Co., Ltd., Nottingham Road, Mansfield, Notts.

WATMEL. (111)

The Watmel Orthotone is a high-class radio gramophone giving an output suitable for home requirements, but is nevertheless considered to be particularly suitable for public hall requirements. The price is 75 guineas. Another Orthotone model is the "Imperial." The cabinet is of first-class design and is 3ft. 6in. in height. The tuning dials of a three-valve receiver are arranged beneath the loud speaker grille, the entire front being closed by doors. A novel feature is that in the event of failure of the battery



Watmel loud speaker unit.

supply the instrument can be used as an ordinary gramophone, making use of the generous sound chamber normally associated with the loud speaker. The set nevertheless is provided with an electrical pick-up, price 25 guineas.

"The 1929 Imperial Three" is an easily built set for the home constructor. The circuit is that of a two-range tuner followed by the detector and two L.F. stages.

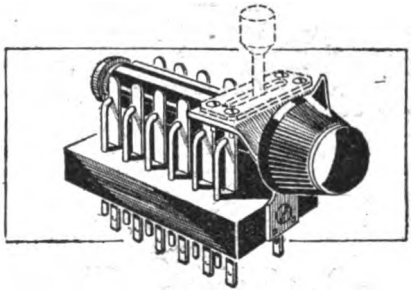
Watmel components include fixed capacity condensers, grid leaks and holders, a two-range reacting tuner, various forms of chokes for use as inter-valve couplings, L.F. transformers, H.F. chokes and switches, as well as a gramophone pick-up arm. A new component of importance is a balanced armature loud speaker movement. The construction is such that the armature is normally in a neutral position between four polarised poles. By this means it is not merely attracted, but its displacement is differential and a generous movement becomes possible. While being sensitive, therefore, generous amplitudes can be handled without loss of adjustment or chattering. This is a well-finished component, and sells at 18s. 6d. Its mounting bracket is arranged so as to provide either a horizontal or vertical fixing.

Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware, Middlesex.

WAVEMASTER (WEBB). (284)

An exhibit of nicely finished variable condensers. Several different patterns are made, and prices are distinctly moderate.

The Webb Condenser Co., 42, Hatton Garden, London, E.C.1.

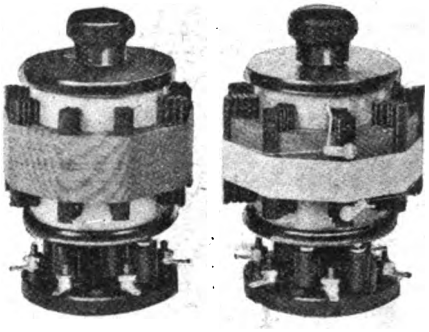


Wearite switch with either lever or knob operation.

WEARITE (WRIGHT & WEAIRE). (221)

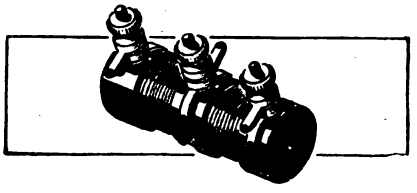
The exhibits at this stand reveal the precision of the instrument-making workshop as opposed to mass production. This fact is conspicuously revealed by the excellence of finish of the Wearite anti-capacity switches. Although these switches are primarily intended for making the many circuit changes necessary in portable sets they meet all amateur requirements and can be safely used in H.F. as well as L.F. and mains circuits. The standard model is convertible from knob to lever operation and can be secured to the panel either by one-hole or bracket fixing.

Coils for home constructors' sets have long been a Wearite speciality, and it is an almost established practice to apply to this firm at once for the coils specified for various designs put out for the home constructor. A wide range of coils can be examined built in accordance with the various set specifications.



Specimens from the range of Wearite coils for the home constructor (The Foreign Listener's Four).

An extension of activities is revealed by the production of mains transformers. Complete separation by means of bakelite sheet between the various windings has been adopted and generous models are available conforming to the require-

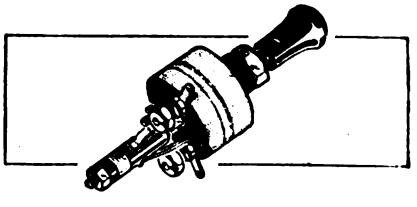


Wearite fixed potentiometer for obtaining a mid-point tap.

ments of the home constructor engaged in the building of a mains receiver. Smoothing and output chokes complete the requirements as regards the construction of mains apparatus. Cast ribbed frames are used for securely clamping the cores of transformers and chokes. Among minor components is a useful potential divider which, with a fixed centre tap, is used for providing a point of zero potential on A.C. circuits.

Genuine paxolin panels and formers are also shown, Wright and Weaire acting as retail distributors in respect of these materials.

Wright and Weaire, Ltd., 740, High Road, Tottenham, London, N.17.



Wearite aerial shortening condenser and switch.

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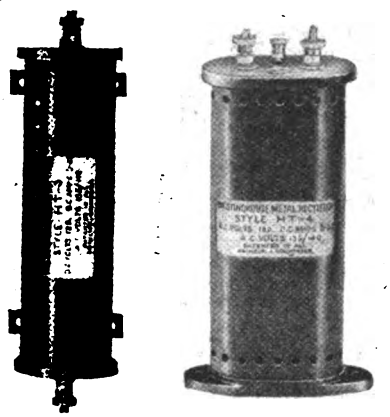
Stand-to-Stand Report.—

WESTINGHOUSE. (13 & 14)

The well-known metal-oxide rectifiers developed by this company, with the exception of the G.B.1 unit for grid bias, have been of the full-wave bridge connected type. These rectifiers have given a very liberal output, and there has lately been a growing demand for slightly less ambitious equipment suitable, for instance, for popular kit sets where the total anode current does not exceed 20 or 30 mA.



(Left) New Westinghouse half-wave rectifier—the H.T.3.
(Right) Westinghouse rectifier (H.T.4) for voltage-doubling circuit.

This need has been met by the H.T.3 and H.T.4 units, which respectively give 20 mA. at 120 volts and 30 mA. at 180 volts; the first mentioned is a half-wave rectifier, in connection with which it is interesting to mention that the ear can tolerate a greater super-imposed ripple voltage at 50 cycles than with the full-wave arrangement giving 100 cycles. The H.T.3 model requires an input transformer, the secondary of which does not give more than 140 volts on open circuit; the price is 21s. The H.T.4 equipment, selling at 37s. 6d., gives a full-wave rectified output, and is used with an ingenious voltage-doubling circuit, whereby the usual bridge of four rectifiers is replaced by a network of two rectifiers and two condensers. The connections are such that the transformer secondary voltage and the peak voltage charge in the condensers are additive, resulting in what is effectively a step up irrespective of the transformer.

The same transformer as that advised for the H.T.3 is used with the H.T.4, and although it only delivers 135 volts from the secondary, the rectifier has an output of 30 mA. at 180 volts. For those whose houses are connected to A.C. mains and who wish to charge their L.T. accumulators at home, the A.3 rectifier, delivering 1 ampere at 9 volts and selling at 23s. 6d., merits attention. The A 4 unit, selling at 39s. 6d., is capable of giving 2 amperes at 9 volts, and besides giving sufficient output for large wireless batteries, is, incidentally, quite useful for charging car batteries. The H.T.1 and H.T.2 equipments for H.T. eliminators, giving 100 mA. at respectively 200 and 350 volts, have been reduced in price to 75s. and 150s.

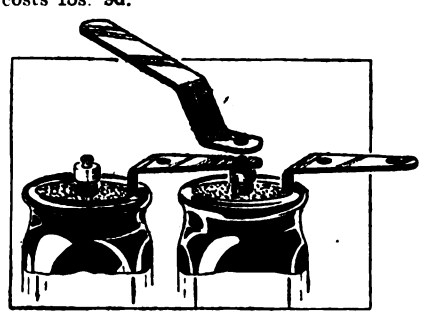
For trickle-charging 2-, 4-, or 6-volt accumulators at 0.5 amps. the R.421 rectifier at 27s 6d. will be retained on the market for the new season.

Westinghouse Brake and Saxby Signal Co., Ltd., 82, York Road, King's Cross, London, N.

WET H.T. (57)

Standard Wet H.T. cells have been improved by manufacturing the elements—zinc, sac, and carbon—in the form of a cartridge, which is merely inserted in a glass container, to which a chemical solution is added. The addition of a cork, which slips over the carbon rod, completes the process of assembly. A new method of interconnection is now provided; the end of each carbon is fitted with a brass cap carrying a spring stud, which engages with a hole in the zinc connecting strip of the next cell. A special tool is provided, and with its help a firm and permanent connection can be made in a moment. The above remarks apply to the large-capacity cells, such as are economical to use for a modern set consuming a fairly heavy anode current. When the cells are exhausted they can be restored to their original condition by fitting new cartridges and fluid.

The use of measuring instruments is always to be encouraged, and it is interesting to note that this firm has produced an inexpensive meter intended for mounting on the panel of a receiver. The Three-in-One Panel Test Meter, as it is called, reads L.T. volts up to 6, H.T. volts up to 150, and anode current up to 30 milliamps. It is supplied complete with a plug board whereby the necessary circuit alterations for obtaining these various readings may be made, and also an ivorine tablet engraved with instructions for inserting the plugs (which are also supplied). The complete equipment costs 13s. 9d.



New method of connecting Standard wet H.T. cells.

An inexpensive milliammeter, in ranges of 0-25 and 0-50 milliamps., is also produced. This instrument operates on the polarised magnet system, and, by fitting jewelled bearings, it has been possible to improve sensitivity and consequently to reduce its resistance. The figure stated to apply to the 0-25 milliamp. instrument is only 20 ohms—a very low value for a meter selling at 9s. 6d.

The Wates "Star" loud speaker unit is a balanced armature mechanism of which the construction is much more robust than that of the average device of its kind. Separate adjustments for setting the spacing between the magnets and the position of the armature are provided.

The products of this firm are demonstrated at 7, Beaconsfield Road, near the Exhibition.

YAGERPHONE. (6)

There are radio gramophones and complete receivers for this season's programme. The Y.59 radio gramophone is a handsome piece of furniture made in oak or mahogany, and contains a large double spring Collaro motor with 12in. turntable. The valve amplifier employs a simple system of resistance coupling with anode-feed devices. There are no transformers at all in the set. For D.C. mains the price is £37 15s., whilst the A.C. model sells at £39 12s. 6d.

The Transportable-Five receiver, retailing at £13 15s., embodies two H.F. valves, which are aperiodically coupled. The volume control consists of a capacity control of reaction, and the last valve—a super-power valve—is choke-filter coupled to the loud speaker. One-dial tuning is employed, and there is a wave-change switch.

There are a number of other radio gramophones and receivers in attractively finished cabinets.

Yagerphone, Ltd., 28, Charlotte Street, E.C.2.

ZAMPA (MIC WIRELESS CO.). (38)

The Universal Tuner, a new season's production, has a built-in inductance control switch and can be used in aperiodic aerial circuits. It covers wavelengths between 250 and 2,000 metres, and embodies a reaction coil.

The double cone chassis comprises two conical diaphragms with diameters of 14in. and 6in., mounted on an oxydised metal frame with fretted front. It requires only the addition of a drive unit to turn it into a complete loud speaker.

The Zampa moving-coil loud speaker has been redesigned and has a novel magnetic system of high-permeability steel. The cone is 8½in. in diameter and is centred by a new device. A 20:1 step-down transformer is mounted within a sheet-metal shroud, which also encloses the magnetic system and is extended to form a base. The instrument is supplied in various forms suitable for battery or mains operation.

A two-valve mains set is designed along novel lines; a two-unit construction is adopted, the radio-frequency and tuning panel being intended for mounting in a position where its controls are accessible, while the amplifier may be placed in any available space in an existing cabinet or other container. Provision is made for gramophone reproduction, for which the pick-up is permanently connected, being thrown into circuit by means of a switch. This set is also supplied in self-contained form.

A low-priced A.C. eliminator, with a half-wave rectifying valve, is exhibited.

Mic Wireless Co., White Horse Place, Market Street, Wellingborough.

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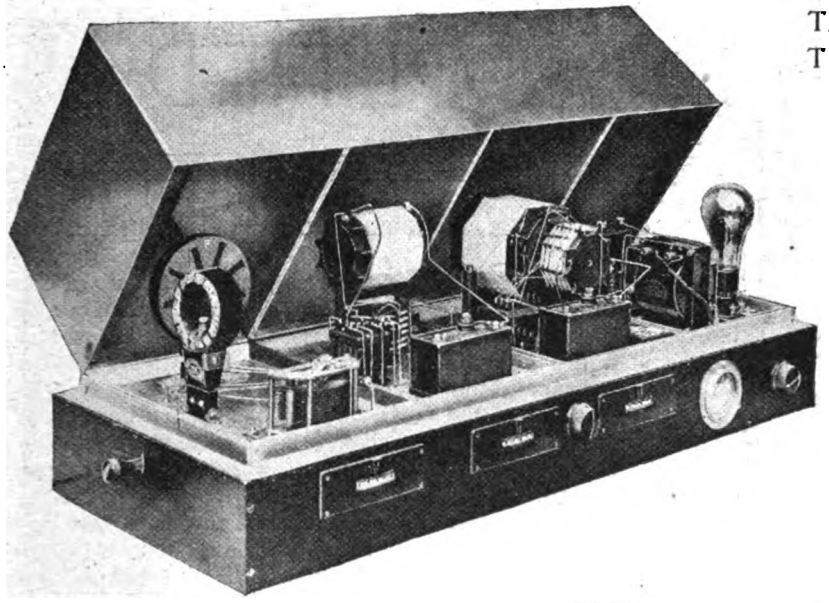
SOME RECENT WIRELESS WORLD RECEIVERS.

THREE TYPICAL CONSTRUCTIONAL SETS DESCRIBED IN THIS JOURNAL.

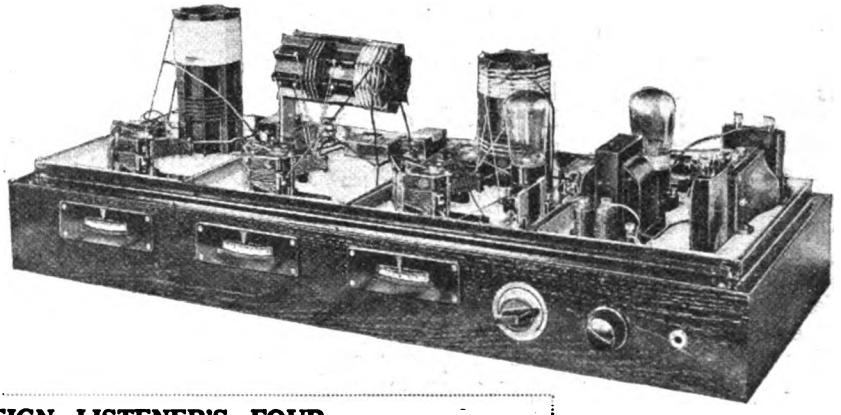


THE WIRELESS WORLD RECORD III.

THIS receiver which was described with full constructional information in the issues of September 4th and 11th was designed to achieve the utmost in single stage H.F. amplification. The measured stage gain is 500, and this established a record which has never previously been approached. A.C. indirectly heated valves are used.

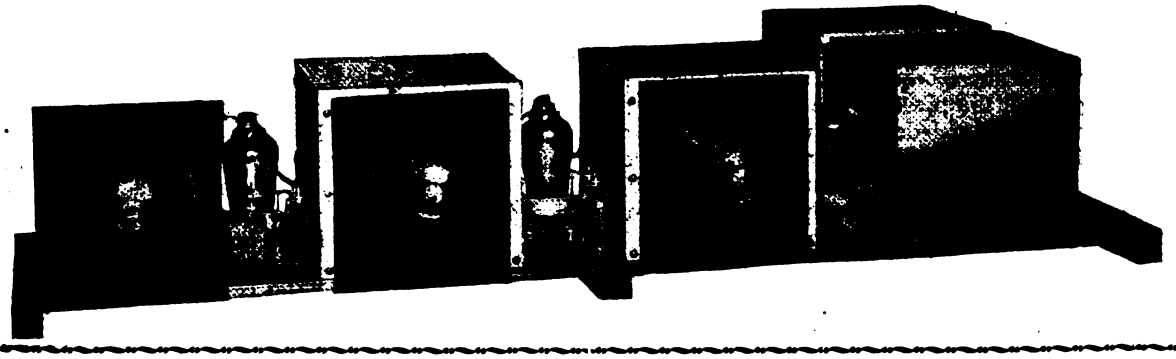
THE NEW KILO-MAG FOUR.

THIS is a redesigned and up-to-date edition of a popular Wireless World set. It employs two H.F. screen-grid stages and gives extraordinary range and selectivity without loss in quality. Complete constructional details are to be found in the issues of August 14th and 21st, 1929.



THE FOREIGN LISTENER'S FOUR.

A HIGHLY selective and sensitive receiver designed to operate entirely from A.C. mains, valves with indirectly heated filaments being employed. The receiver is simple to build and gives loud speaker results on most of the best European programmes. This receiver was described and illustrated with detailed constructional drawings in the issues of July 31st and August 7th, 1929.



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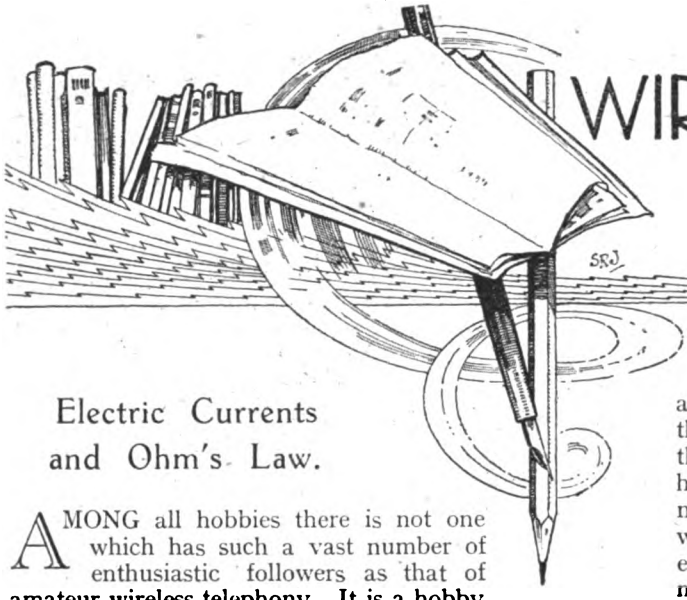

WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

Electric Currents and Ohm's Law.

AMONG all hobbies there is not one which has such a vast number of enthusiastic followers as that of amateur wireless telephony. It is a hobby which has a lasting fascination for young and old alike, and holds within its sway not only those who have had a technical training in electricity, but tens of thousands who would possibly never even have heard of Ohm's law but for wireless—people in every walk of life.

Technical Progress.

One of the factors which keeps the hobby so much alive is the rapid rate of development and improvement in the efficiency of receiving sets. One has only to remember that not much more than five or six years ago it was common practice to try a circuit out with the various components placed loosely on a bench or table, and then, having got it to work without howling or oscillating after a great deal of trouble, to attempt to transfer it to a cabinet, often with disastrous results! Compare this with the modern apparatus where scientific screening and screen-grid valves or neutralisation are employed. The modern receiver *must* be built once and for all in its final form as far as the set constructor is concerned. Experimental work has become more tedious and expensive, and this has led to the publication by *The Wireless World* of complete specifications of highly efficient sets designed and tried out in the laboratory. Manufacturers of various components have also designed sets embodying their particular apparatus, and offer for sale complete kits of parts with the necessary diagrams and instructions.

It would be very interesting and enlightening to know what percentage of those who construct their own wireless receiving sets at the present time do so according to the precise constructional details given in the various radio journals, without even an elementary knowledge of the theory underlying the respective designs. Possibly there are some who would argue that it is waste of time to bother about theory when such complete instructions are available, all the brain-work having been done by someone else! But the writer feels convinced that on the whole the great majority of set constructors are very keen to know the why and wherefore of everything relating to their respective sets, and more often than not feel envious of those of their friends who have had a grounding in the theory of electricity and magnetism. After all, there is not much satisfaction in working in the dark, and an elementary knowledge of electricity and magnetism as applied to radio adds enormously to the interest of the work, and saves many a pit-fall.

Perhaps one of the commonest problems met by the present-day amateur is how to adapt a new design of receiver so that it can be housed in his existing cabinet, the old set having become obsolete and inadequate to meet the present-day standards of range, selectivity and quality of reproduction. This applies in particular to cases where the cabinet is an expensive one. Or, on the other hand, it may be desired to bring an existing set up to date by making certain alterations. Armed with a little theoretical knowledge, the amateur will be able to judge for himself what alterations as regards lay-out would be permissible in any specified design or which of the old components could be used in the new set. And, most important of all, it is the man with some theoretical knowledge who generally gets the best results from his set, and is usually able to locate a fault quickly should one develop.

In writing this series of articles the author realises that possibly there will be among his readers quite a number who have not approached the theoretical side of the subject at all, and, bearing this in mind, every attempt will be made to render the treatment as simple as possible, and numerous examples will be worked out to simplify matters still further.

The Electric Current.

In a receiving set currents of electricity are controlled by various means in order to produce the desired effects in the various sections of the receiver. In the first place, what is a current of electricity? We talk of it as something which flows, as though it were some kind of fluid passing through a wire or conductor, and yet that conductor will have the same dimensions and weight whether there is a current flowing in it or not. But the conductor will become heated to some degree, and this may be the only evidence we have that a current is passing. The point is that a current of electricity does not affect our senses directly, but manifests itself

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Wireless Theory Simplified.—

by its peculiar effects, and it is these effects which are utilised in the various ways to be described as we proceed.

The notion that a current of electricity is something which flows is an excellent one, and the discovery of the existence of electrons has proved that there is a great deal of truth in it. Let us compare our wire carrying the current to a hose-pipe connected to a tap which is turned on, so that there is a current of water flowing through it. The pipe and the running water within it will have a definite and constant weight because water is entering at one end exactly at the same rate as it leaves at the other. Suppose now that the tap is turned off with the nozzle end of the hose held above the level of the tap so that the pipe remains full of water. The weight will still be the same when the flow of water has ceased.

Electrons.

We may view the wire carrying the current of electricity in exactly the same way, but, before completing the analogy, it will be necessary to introduce and define briefly what is meant by an electron. According to the generally accepted electron theory, every atom of matter is built up of a number of minute negatively charged corpuscles moving in definite orbits around a central positively charged nucleus. These minute outer corpuscles each carry an equal negative charge, and are called *electrons*. Each electron possesses the same mass, and is so small that, comparing it with an atom of matter, Sir Oliver Lodge once likened it to a fly in a cathedral!

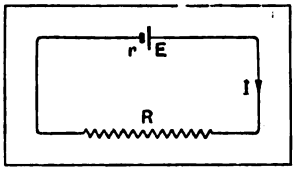

Fig. 1.—Simple closed circuit containing battery and resistance.

We are not concerned with the structure of the atom, the nature of which is determined by the number of electrons moving in definite orbits round the nucleus, but with the fact that each atom has attracted to it large numbers of free electrons which may be withdrawn or moved from atom to atom. It is the *motion* of these electrons in any definite direction which constitutes an electric current; that is to say, a current of electricity in a wire is a stream of electrons passing along the wire from atom to atom entering at one end and leaving at the other. When the current is "switched off," the electrons simply stop moving and remain where they are just as in the case of the hose-pipe, where the water came to rest when the tap was turned off. Hence even a piece of wire which is not carrying a *current* of electricity is, nevertheless, full of electricity in a stationary state. To start a current then all that we do is to set in motion streams of electrons which already exist in the circuit. This will explain why the weight of a conductor remains unchanged when a current of electricity is passed through it in spite of the fact that the electrons themselves have mass.

We must now consider the strength of the electric current and the unit in which it is measured. The strength of the current is represented theoretically by the number of electrons which pass a given point in the circuit every second, but as the electrons cannot be counted in practice, the strength of the current is gauged in terms of its physical effects. The practical unit is the *ampere*, and is defined internationally as that steady current which deposits 0.001118 gram of silver per second by electrolysis—that is, by the process used in electro-plating.

Electromotive Force and Resistance.

To start and maintain an electric current, *i.e.*, to set electrons in motion in a circuit, some sort of force is necessary just in the same way as force or pressure is required to drive the water through the hose-pipe, the magnitude of this force depending on two things. Taking the hose-pipe equivalent first, the necessary pressure will depend on (*a*) the quantity of water required per second, and (*b*) the nature and size of the pipe. Obviously, to get a rapid flow through a thin pipe will call for a large pressure, and *vice versa*. Similarly in the electric circuit the necessary driving force, which is called the *electromotive force* (E.M.F.) will depend on (*a*) the quantity of electricity passing per second, *i.e.*, the current, and (*b*) the opposition offered to the passage of the current by the conductor itself.

This opposition is what is referred to as the *resistance* of the conductor. It can be looked upon as a frictional resistance offered to the passage of the electrons through the conductor. Resistance is measured in ohms, the ohm being defined internationally as the resistance of a column of mercury of certain specified dimensions. The resistance of a conductor depends on its dimensions, the material from which it is made, and very often upon the temperature. The metals have low resistance and allow the current to pass easily, whereas ebonite, glass and all so-called insulators offer such high resistance that it is only possible to drive the minutest currents through them. Dry air is one of the best of insulators—what a calamity if it were not!

Ohm's Law.

It was discovered by Ohm that a definite simple relationship exists between the current, electromotive force and resistance in a circuit, namely, that the E.M.F. required to drive a current through a conductor is exactly proportional to the strength of the current and to the resistance of the conductor. This is known as Ohm's Law and can be applied to any circuit where the current is a steady one. (The laws obeyed by alternating currents will be discussed later.)

The practical unit of electromotive force is the *volt* and may be defined as that electrical pressure which is necessary to drive a steady current of one ampere through a resistance of one ohm. If a conductor has a resistance of R ohms and it is desired to drive a current of I amperes through it, we see from Ohm's Law that the required electromotive force will be $E = I \times R$ volts. Or if we know the E.M.F. and the resistance the current is given by $I = E/R$ amperes; and similarly the resistance is $R = E/I$ ohms.

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Wireless Theory Simplified.—

Numerical Example.

Ohm's law is thus seen to be a very simple one, but when a circuit consists of more than one resistance or contains branches care must be observed when applying it. As an example let us consider the simple closed circuit of Fig. 1, where a battery whose E.M.F. is E volts, and which has an internal resistance of r ohms (for, like a conductor, even a battery has resistance), has connected across its terminals an external resistance of R ohms. A current will flow round the closed loop through the *two* resistances R and r in turn, so that the total resistance of the circuit will be $R+r$ ohms. Denoting the current by I and applying Ohm's law to the complete circuit we get $I=\frac{E}{R+r}$ amps.

To take an actual case, suppose that the battery is a 6-volt accumulator whose internal resistance is 0.2 ohm, and that the external resistance R is represented by a number of valve filaments having a combined resistance of 3 ohms. The current drawn from the battery will then be,

$$I=\frac{6}{3+0.2}=\frac{6}{3.2}=1.875 \text{ amps.}$$

(*This same circuit will be considered in greater detail in the next part.*)

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

TECHNICAL ASSISTANTS AT OLYMPIA.

Sir,—May I be allowed to bring to the notice of those concerned a glaring fault I noticed at last year's Wireless Exhibition?

I attended the show on the opening day, taking a day trip up specially to see it.

I noticed that, with hardly an exception, those in charge of the stands were conspicuous for their extraordinary lack of technical information. One could purchase any article, but as for getting any satisfactory characteristics of the various transformers, chokes, coils, and valve efficiency, the ability to give this was beyond the average assistant.

Now we who go to the show go with an object, not just to see how pretty it all is. We want information and facts, not suppositions. I was told that "experts" would be in attendance on Monday (the show opened on a Saturday) and other days.

I propose to visit the Exhibition this year and I want a lot of information, besides what will occur to me during my wander round. I hope it will be forthcoming.

I might add that friends of mine found the same trouble even when "experts" were supposed to be present.

E. J. B. CURTIS.

AMATEUR STATUS.

Sir,—I should like to draw the attention of all those amateurs who appear disgruntled with our position to a leading article, by the President of the American Radio Relay League, in the September number of the magazine *QST*.

For the benefit of those who do not read *QST*, may I quote just a few passages from the article?

"Sometimes I wonder if a good many of us A.R.R.L. people are not inclined to overlook big matters just because somebody talks a good deal about small matters. Every now and again somebody starts trying to pull apart our A.R.R.L. because Headquarters has done, or has not done, something or other.

"Whose A.R.R.L. are they trying to pull apart? Is it Headquarters' A.R.R.L.? Not a bit of it. It is your and my A.R.R.L. and the other fellows' A.R.R.L they are pulling apart.

"Have you ever stopped to think what the effect would be were we radio amateurs to adopt those methods? We would have twenty or thirty different warring amateur radio organisations all shouting at each other, calling each other names, and demanding different things. How far would Amateur Radio get?"

Now, surely, this is the very sort of storm in a teacup that some are trying to stir up at the moment in this country; and, if so, are they not "small matters"?

Well, it is "my A.R.R.L." just as it is "my R.S.G.B.." and both are out to uphold the honour of amateurs, provided the amateur is out to uphold his own honour and the honour of "Ham" Radio.

The whole situation sums up to the fact that every amateur must lend his weight to the common cause, and not to individual taste. If the latter is in the majority, then we can add the letters "R.I.P." after Amateur Radio. G2ZC.

Sir,—It occurs to me that my previous letter to you, reproduced in your issue of August 21st, under the heading "What the A.R.R.L. Thinks," may be misconstrued by many British amateurs.

Naturally, we wish it well understood that, as stated in my previous letter, the comment referred to your editorial in the issue of July 10th, wherein you commented on the attitude of the British Government authorities toward British amateurs.

My comment is in no way to be taken as applying to any other editorials.

A. L. BUDLONG,
Assistant to the Secretary.

The American Radio Relay League.
Hartford, Connecticut, U.S.A.

Sir,—The question of the amateur status has unfortunately resolved itself into an argument as to which is the best organisation. May I inform all intending correspondents that Mr. Bradley's assertion that the A.B.R.S. talk to the exclusion of action is disproved by the fact that action has been taken in conjunction with the R.S.G.B. whereby some benefit may accrue to the whole of the amateur movement.

In the meantime I do feel it is necessary to prevent any misunderstanding arising from the paragraph in Mr. Lawrence Fuller's letter published in the September 11th issue. Mr. Fuller is evidently unaware of the full facts of the case referred to in my previous letter. The affair in question was not a concern of the A.B.R.S. but the Manchester Radio Scientific Society, and was taken up by the A.B.R.S. after the said Society had fought a good deal of the battle themselves, and further, he proves by stating that any amateur would have such restrictions imposed upon him, that he knows practically nothing of the case at all, and I would advise Mr. Fuller to make himself *au fait* with the whole of the circumstances before he dares to comment in such a journal as yours.

In any case, it does not matter one iota who is the premier society or organisation that has done this or that, but what does matter is that the amateurs of this country shall cease quibbling amongst themselves, and get down to brass tacks to improve their status, and their general line of action in connection with a science which provides more field for study than for argument.

Manchester. J. E. KEMP.

RE DECAPPING VALVES.

Sir,—A quick method is, after unsoldering the wires, to bring the valves gently to the boil in water. The cement will be softened, and the base can be removed entirely without damage. The process takes five minutes or so.

Henley-on-Thames. V. PHYLLIS GEORGE.

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READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Without Decapping.

Will you give me an idea as to what results should be expected from a "Record III" receiver constructed in accordance with the published specification, but without the "decapped" detector valve? V. L. M.

With this modification, the receiver would still have a performance well above the average, but amplification would be appreciably reduced, and the special advantage of the detector grid circuit with regard to its inductance-capacity ratio would to a certain extent be lost. It would be necessary to remove several turns from both primary and secondary windings of the medium-wave H.F. transformer.

oooo

Modifying the Original "Regional" Set.

I am thinking of modifying my original "Regional" receiver (with a neutralised triode H.F. valve) by fitting the auto-transformer-coupled tuned aerial arrangement of the new "S.G. Regional" receiver. My object is to attain even higher selectivity than at present: do you consider that the proposed modification will justify itself by results? J. H. W.

It cannot be denied that the aerial coupling arrangement included in the new version of this set enables the operator to make a better adjustment of coupling between the two circuits, and in your locality we should expect that the consequent gain in selectivity should be worth while, but only if a screen is interposed between aerial and secondary coils.

oooo

"Record III" Gramophone Attachment.

I have started to build the "Record III" receiver, and should like to know if it is possible to fit a gramophone pick-up. If permissible, I propose to use a jack, arranged so that the insertion of the plug (to which the pick-up will be connected) will automatically convert the present detector into a first-stage L.F. amplifier.

Will you please let me have a circuit diagram showing a suitable method of connection? C. B. A.

It should in the first place be pointed out that, due to the high H.F. stage magnification afforded by this set, great care must be taken to avoid the addition of leads in the grid circuit which might be responsible for interaction. However, if reasonable precautions are observed, it should be quite possible to modify the set in the manner you propose, and we give in Fig. 1 a circuit showing a suggested scheme. It will be obvious that the body of the jack must be insulated from the metal screening case, otherwise a short-circuit across the bias battery would be introduced.

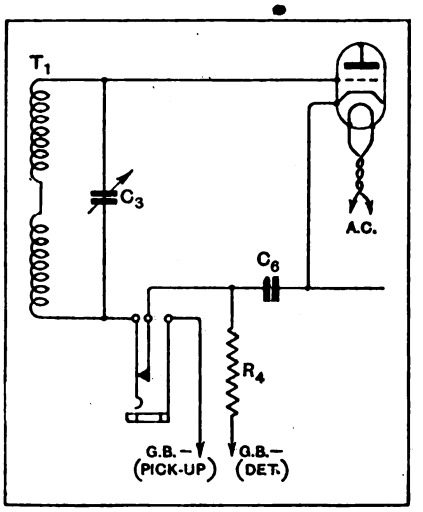

Fig. 1.—Converting the "Record III" for gramophone reproduction. The pick-up is connected to the jack plug.

Reference lettering in Fig. 1 corresponds with that in the original circuit diagram. It will be hardly necessary to add that the extra bias connection shown is for supplying the detector valve when converted to function as an amplifier.

oooo

Electric Gramophone Motor.

I am having a certain amount of trouble with induction effects between my recently installed gramophone motor and the L.F. amplifier of a radio-gramophone receiver. This seems to be due mostly to sparking between brushes and commutator, which cannot be entirely obviated, in spite of the most careful attention. Can you suggest an easy and simple method of effecting a cure? S. R. C.

We think that you would be well advised to try the simple expedient of connecting two large condensers in series across the brushes, and joining the connection between the condensers to earth. The capacity of these by-pass condensers should be as large as possible—not less than 4 mfds. each.

oooo

Pentode Economy.

Will you please tell me how to reduce the total anode current consumed by my pentode output valve, without in any way sacrificing quality of reproduction, which is at present quite satisfactory? D. T. B.

Unless you are satisfied with reduced volume, we fear that it will be impossible to retain your present quality of reproduction and at the same time to reduce the consumption of current from the source of H.T. supply. (It is, of course, assumed that the valve is being worked under the correct operating conditions.)

It is usual to reduce anode current both by overbiasing the grid and by reducing the voltage applied to the pentode screening grid. We suggest that you experiment with both of these schemes, finally adopting the working conditions found by trial to give the most pleasing results with the anode (and screen) current that you can comfortably provide for the valve.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Eliminator Dangers.

I am told that it is possible to get a serious shock from wireless receiving apparatus when head telephones are connected to a set supplied with H.T. current through an eliminator. Do you agree with this, and, if so, will you outline briefly the necessary precautions to take in order to obviate all risk of danger from this source?
E. V. N.

It is generally agreed that head telephones should not be connected directly in the anode circuit of a valve to which a high H.T. voltage is applied; this is irrespective of the souce of supply. When the set is fed from D.C. mains, it is almost inevitable that one pole of the supply will be earthed, and also in connection with the set; this increases the risk of an electric shock to the operator; but, apart from this fact, it is safe to say that a well designed and well-constructed eliminator is practically as safe to use as a battery of the same maximum voltage.

As for safety precautions, a double-wound output transformer, with adequate insulation between primary and secondary, will render the set perfectly safe to use with headphones, as will the use of a choke-filter output device, although, to be on the safe side, it is recommended that blocking condensers should be fitted in each of the telephone leads.

oooo

Field Magnet Current.

Is there any reason why the field magnet winding of a moving-coil loud speaker should not be supplied with current from the battery used to heat the filaments of the receiving set?
E. N. P.

No; it is quite usual to employ the ordinary L.T. battery for the dual purpose of heating filaments and energising the magnet. Of course, before doing so you should assure yourself that the capacity of your battery is adequate for the demands that will be put upon it.

oooo

A Substitute for H.F. Amplification.

As you will see from my address, I live but a few miles from the Brookmans Park transmitter. Having listened to initial tests from that station, I have come to the conclusion that an exceptionally selective arrangement will be necessary here in order properly to separate the twin transmissions (when they begin), but signal strength is so great that for purely "local" work H.F. amplification would appear to be unnecessary. It seems to me that the use of cascade tuned filters in conjunction with a tuned and loosely coupled aerial circuit would provide a useful solution of my problem, and I should be obliged if you would give me the diagram of a recommended circuit, preferably with not more than three tuning controls. An anode bend detector will be used, as it is realised that this will be helpful in reducing interference. S. F.

Your reasoning is quite sound, and we think it should not be difficult for you to devise an arrangement capable of affording the necessary selectivity: due to the proximity and high power of the new station, there should be no doubt that signal strength would be more than sufficient with the circuit arrangement shown in Fig. 2. In this diagram, L and C represent the aerial loading inductance and aerial tuning condenser, while L_1 and C_1 are in the intermediate tuned circuit: L_2 and C_2 form the tuned detector grid circuit. It will be observed that a few

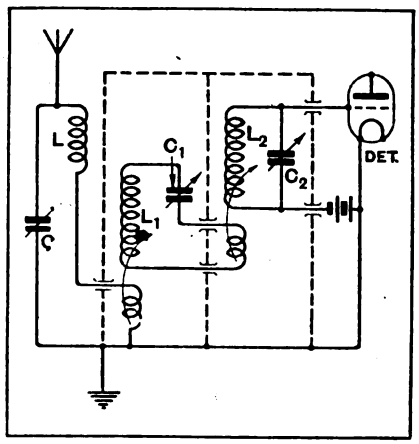

Fig. 2.—Intermediate filter circuit combined with separately tuned aerial.

turns of wire (for coupling purposes) are connected in series with L and L_1, and that thorough screening (indicated by dotted lines) is provided in order that coupling may be well under control.

oooo

H.T. and L.T. Inter-connection.

I have a receiver in which H.T. negative is joined internally to the L.T. positive bus-bar. It is noticed that this is opposed to the practice adopted in all the receivers described in your journal, in which H.T. negative is invariably shown as connected to L.T. negative. Would it be worth while altering the set to conform with this method of connection? P. R. G.

As far as performance is concerned, this is a very small and unimportant matter, and a change in connection would not bring about any improvement, except, possibly, in one of those comparatively rare cases in which interstage coupling and consequent instability is brought about by the negative-positive connection.

The method adopted in *The Wireless World* sets was first standardised mainly as a safety measure; there can be no doubt that it reduces the risk of accidental damage to valve filaments.

oooo

Neon Lamps.

Your recent article, "The Neon Lamp as a Stabiliser," suggests an easy way of improving my eliminator. Can you tell me where the special lamps can be obtained? S. N.

Neon lamps, sold under the trade name of "Osglim," are manufactured by the General Electric Company, Ltd., and should be obtainable through your dealer.

A.C. Valves Without A.C.

It so happens that I can recharge my L.T. accumulators at little cost and without much trouble, and in consequence I am considering the possibility of using A.C. valves with their heaters supplied with current from an accumulator battery. (The mains here are D.C.) My particular problem is to know whether it would be permissible to use these valves (with heaters taking 1 amp. at 4 volts) in conjunction with a Px.650 valve in the output position. As you know, this valve requires a 6-volt battery. Would there be any harm done by feeding the heaters of the indirectly heated valves from the same source through a voltage-absorbing resistance? L. C. H.

Beyond the fact that current consumption will be high, there is no objection to your proposed plan, but care must be taken to see that the resistance (or resistances) used for absorbing the surplus voltage are of adequate current-carrying capacity, in addition to being of the correct ohmic resistance. These points can be decided by consulting the wire tables appertaining to the particular brand of resistance wire you desire to use.

oooo

Chokes for Decoupling.

Is there any reason why an L.F. choke should not be used for decoupling purposes in place of the resistance which is commonly specified? I ask this question because I wish to "decouple" the anode circuit of a valve in which no very great drop in voltage can be tolerated. W. B. J.

A choke can often be used quite successfully for this purpose; indeed, it is possible to visualise conditions where it would be more effective than a plain ohmic resistance of the highest value ordinarily permissible. It must not be forgotten, however, that the impedance of a choke falls off with a decrease in frequency; and, if the amplifier is so designed that it passes on the lower audible frequencies at full strength, it is quite possible that the choke would not be effective, and that motor-boating would take place.

oooo

Detector H.T. Voltage.

Although it is usual to specify for a grid circuit detector an H.T. voltage not greatly in excess of 60, I notice that occasionally a pressure of as much as 120 volts is recommended. Will you tell me the reason for this, as a study of one particular receiver for which this detector voltage is advised does not reveal any special feature in the circuit arrangement. T. T. B.

In cases where a comparatively high anode voltage is recommended for a "leaky grid" detector, it will almost invariably be found that the valve is of the high-impedance type, of the kind usually sold for resistance-capacity amplification. By applying a high anode voltage, the working impedance is reduced to a value where it becomes possible to insert an L.F. coupling transformer in the anode circuit, giving a step-up in voltage to the first L.F. valve.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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THE BATTLE OF THE GIANTS.

THE "Plan de Prague," which came into operation at the end of June last, based on decisions previously taken at the Washington Conference, made the best of a bad job, namely, an attempt to fit into a narrow broadcasting band an innumerable list of European transmitters. Many exclusive wavelengths were cut down, more common waves were created, and others were shared by two or more countries; in fact, every effort was made to satisfy most of the claimants whilst still adhering to a co-ordinated plan with a view to securing a degree of order in the ether.

From the date it was carried out the "Plan de Prague" in turn has been highly praised or ruthlessly condemned, and it would be difficult for the average listener to distant stations to express his opinion regarding the success or failure of the scheme. Are general conditions better or worse than they were a year ago? An evening spent with a highly selective wireless receiver will demonstrate that, like the proverbial curate's egg, the broadcasting band is good in parts; but the small separation between frequencies necessitated by the narrowness of the band and the number of wavelengths to be allocated does not give sufficient elbow room, especially as on most nights some stations stray from their official positions.

For close on three months the authorities have been given an opportunity of studying the working of the scheme, and at The Hague, where a conference is being held, the matter again comes up for general discussion. For the present it is difficult to see how any improvement can be made so long as the broadcasting band remains within such narrow boundaries, and stations are as numerous as at present. The Prague Plan, in its foundation, is based on the aerial energy of the respective transmitters, at the time it was prepared. This important factor is changing rapidly and is likely to annihilate the entire scheme.

Gradually, with the evolution and development of the wireless programmes, most authorities have put forward schemes either for an increase in the number of stations to supply an extended service or, alternatively, an increase in the power of the transmissions, thus obtaining greater range. With the centralisation of activities in the respective capitals, the latter scheme has been mostly favoured, and if a short study be made of the developments which are taking place in a number of European countries, it will be found that within the last year many additional high-power transmitters have come into operation. Moreover, the constructional programmes of most foreign broadcasting concerns call for a further increase. Taking Great Britain alone, the new Brookmans Park dual transmitter will work with an energy of 30 kilowatts in the aerial; and we are promised in the future four more similar installations.

On the Continent we find proposals to endow Strasbourg with a 12-kilowatt station, and to erect a 30-kilowatt transmitter at Bordeaux. Madrid intends to use 20 kilowatts, Barcelona 10, Rome 50, Milan 20, Naples 7, Prague 60, and so on.

If it is assumed that certain individual countries will look to an increased transmitting energy as a means to rid themselves of interference both local and distant, and thus ensure a better service to their licence-holders, we may be sure this example will be followed generally, with the inevitable result that the "Plan de Prague" must fail.

So far as can be foreseen, the near future will bring with it a Battle of Giants, an event which will benefit no individual country, but which, on the other hand, in the present limitations of the wave band, will sadly hamper broadcasting developments in Europe.

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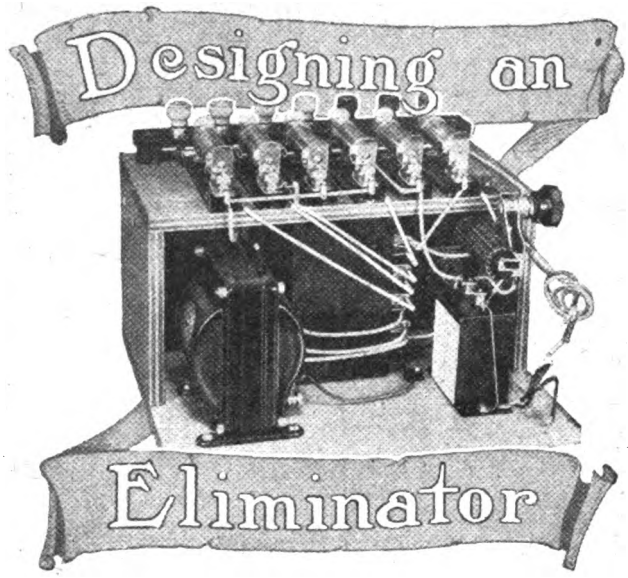

Notes on Current Practice in Home-constructed H.T. Mains Units.

By W. I. G. PAGE, B.Sc.

PROBABLY the largest item in the upkeep of a simple radio receiver is the high-tension battery. Notwithstanding this, there are many listeners who have electric light in their houses and who refrain from constructing an H.T. battery substitute because they fear that the calculation of the resistance values and the design of the filter to suit their sets is too complicated for them. Let it be said at once that the science of decoupling or the process for preventing unwanted couplings when two or more A.C. potentials are common to one circuit has been so thoroughly developed during the last year that H.T. eliminators can now be designed either for A.C. or D.C. in which there is no trace of motor boating, hum, distortion, or loss of amplification.

Besides the obvious advantage conferred by a mains unit of a trouble-free anode supply, there is the question of economy. It should be pointed out that a unit of electricity can be purchased from a lighting company for, say, 5d., whilst the cost of a unit obtained from high-tension batteries would be about 30s. to 40s. Thus an A.C. eliminator costing, perhaps, £5 to £6 would soon pay for itself. Another advantage is the constancy, within small limits, of the voltage of the supply mains and the fact that power valves with a more liberal anode current than that usually to be extracted from batteries can be included in a mains set without producing any noticeable increase in the quarterly lighting bill.

Voltage Regulation.

There are several fundamental differences between battery and mains supply. First, a change in current in the feed to any valve, when a battery is used, is not accompanied by any serious change in voltage, whereas with an eliminator, owing to the common resistance network which is always present, the voltage-current relationship is a steep slope known as the voltage-regulation curve. If, for instance, the power valve of a mains receiver is exchanged for another having double the anode current, the plate voltages on all the other valves will drop. Our aim, therefore, is to design an eliminator with the minimum common internal resistance. Secondly, if, when using a battery, we desire a voltage below the maximum (perhaps for the screen of an S.G. valve), we simply make connection to the necessary tapping, but we cannot obtain a lesser voltage than that of the mains unless we use a resistance. Here, again, a change in feed current results in a change in applied voltage. This difficulty is partially overcome by using separate potentiometers for all feeds of, say, 2 mA. and under, the resistance values being so chosen that the constant current passing through the potentiometer is over four times that of the feed to the valve.

Where a power valve is concerned it would be uneconomical to use a separate potentiometer; a series resistance is used in its place. Thirdly, to smooth out the ripple which is always superimposed on D.C. mains and is present in rectified A.C., it is necessary to make unstinted use of inductance and capacity, the association of which will inevitably mean resonance at some low frequency. There are certain minimum inductance and capacity values which must be exceeded to prevent the circuit being tuned to a frequency above about 25 cycles, otherwise hum will be heard in the loud speaker. A high-tension battery is devoid of ripple troubles, but with age will develop an appreciable internal resistance which, however, will be independent of frequency.

Filter Circuits.

In brief, by comparison with a battery, an eliminator has a high internal resistance producing a sloped voltage-current regulation curve, a resonant frequency, no direct means of providing a lower voltage than the mains except by voltage-dropping resistances, and sufficient common impedance to necessitate the deflection of speech currents which would otherwise cause low-frequency reaction and various forms of interruption. The filter in Fig. 2 for A.C. or D.C., used with or without one of the rectifiers of Fig. 1, is designed to be a fair compromise between cost and the ideal condition where the various difficulties are avoided. It should be noted that no potentiometer is included that is common to two or more circuits (except in the case of the feeds to two S.G. valves).

We can now discuss the relative merits of the various forms of rectifier available for H.T. mains units for A.C. The valve rectifier is cheap, but has a filament of limited life, and where the full-wave type is used a tapped transformer of rather elaborate design must be employed, having a voltage of, perhaps, 500 across the outers of the secondary. The dry copper-oxide metal rectifier, being electronic in action, has a practically everlasting life, its efficiency is about 70 per cent., and its internal resistance is lower than that of the valve, so that the voltage regulation curve is less steep. Full-wave metal oxide rectification is effected by a bridge circuit, and the transformer secondary is

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Designing an Eliminator.—

untapped and need have a voltage little in excess of that across the primary. The metal rectifier is rather sensitive to overload, and should always have a flash lamp fuse incorporated (fusing point between 100 and 200 mA.), and not more than 4 mfd. shunted immediately across the output, otherwise the A.C. load may be too heavy.

All rectifiers, except the voltage-doubling condenser bridge circuit, should have a reservoir condenser immediately across the output to charge up during the rise in voltage and to discharge into the load circuit during the voltage decline. With regard to the merits of half-wave and full-wave rectification, it should be stated that the former is rather cheaper where small outputs are desired, and although the rectified output is 50 cycles from a 50-cycle supply, the ear can tolerate from the average loud speaker without annoyance quite a large amplitude of ripple at this frequency. Full-wave rectification gives an output of 100 cycles from a 50-cycle supply, and less smoothing equipment is required to give the same freedom from ripple as compared with the half-wave method, but 100-cycle ripple is more audible from the loud speaker. It is thus rather a question of swings and roundabouts. For large outputs full-wave rectification has the greatest application.

In Fig. 1 (*a*) and (*b*) full-wave and half-wave valve rectification is shown. In (*c*) a metal-oxide full-wave bridge is illustrated. A Westinghouse unit of this type,

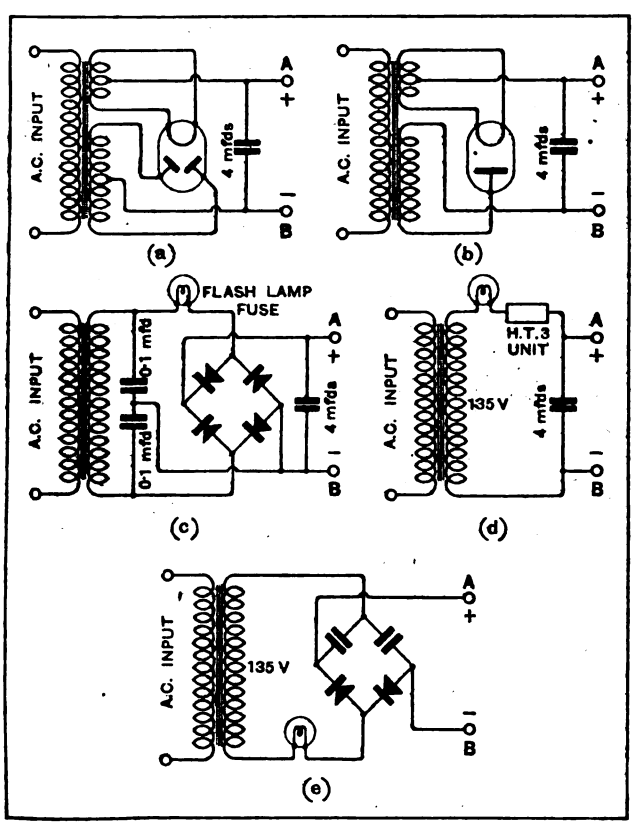

Fig. 1.—Five methods of rectification at present in use. In each case the terminals A and B are connected to a smoothing circuit such as that shown in Fig. 2. (a) Circuit for full-wave valve rectifier. (b) Half-wave valve rectifier. (c) Full-wave bridge with metal-oxide rectifier. Note the double 0.1 mfd. condenser across the transformer secondary. (d) Half-wave Westinghouse metal rectifier (H.T.3). (e) Condenser-rectifier bridge giving full-wave rectification and a voltage step-up irrespective of the transformer.

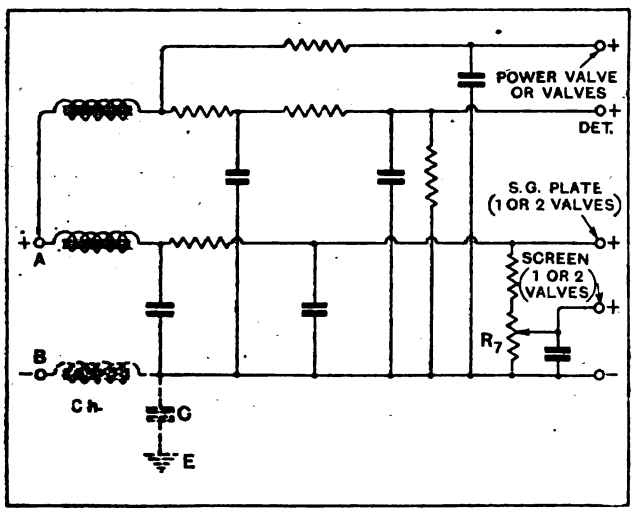

Fig. 2.—A comprehensive smoothing and voltage-dropping circuit for modern 3-, 4- and 5-valve receivers. The terminals A and B can be connected to any of the five rectifiers in Fig. 1. If a choke Ch and an earth condenser C (shown in dotted lines) be added, the above circuit becomes an efficient H.T. eliminator for D.C. mains.

known as the H.T.I., is manufactured giving the large output of 100 mA. at 200 volts, thus being suitable for moving coil speakers; note should be made of the flash lamp fuse and the centre-tapped double 0.1 mfd. condenser which will remove the last traces of hum. In (d) a Westinghouse H.T.3 half-wave unit is shown; the transformer secondary should give 135 volts and the smoothed voltage output will be 120 when the load is 20 mA.—a sufficient anode supply for most 3-valve kit sets. An interesting condenser-rectifier bridge, known as the H.T.4, is shown in (*e*) which gives a step-up irrespective of the transformer. With a load of 30 mA. the voltage developed is 180; with 50 mA. (the maximum permissible) the voltage is 150, both these outputs being obtained with 135 volts across the transformer secondary. This "voltage-doubling" device functions by virtue of the fact that the peak voltage charges in the condensers and the secondary voltage are additive. As explained in the inscription, the circuit of Fig. 2 can be used as a complete D.C. eliminator, while for A.C. it can be connected to any of the rectifiers of Fig. 1. Potentiometers are included where the valve current does not exceed 2 mA., and a desirable refinement for critical screen voltage control is used wherein one limb of a potentiometer consists of a continuously variable wire-wound potential divider.

The various 2 mfd. condensers can conveniently consist of a single tapped condenser block which confers the benefit of compactness, easy wiring and, last but not least, cheapness. Interchangeable clip-in resistances are used except for R_7 so that the anode feed may easily be changed to suit any valve.

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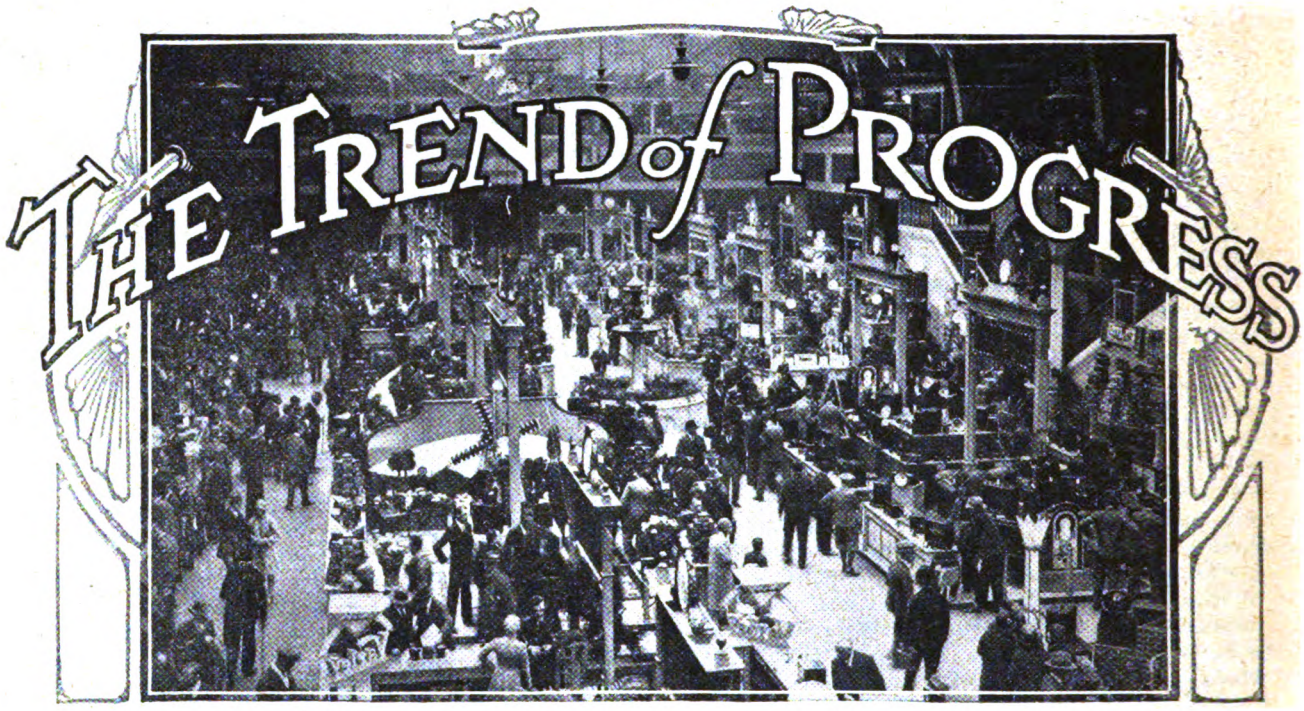

Our Impressions of Olympia, 1929.

THE outstanding impression carried away after a visit to Olympia has been that real progress is in evidence in almost every section of the Exhibition, and in the pages which follow we endeavour to present to the reader our views on what are the principal indications of progress made during the past year in the design and production of apparatus of all kinds. Something should also be said for the Exhibition itself, for therein, too, we have an illustration of the growing importance of the wireless industry of this country and a definite indication of its increasing stability.

The days appear to have passed when firms of mushroom growth came into the wireless industry with no experience of technical ability, but merely with the intention of making capital out of the ignorance of the general public in technical matters. To-day it is almost impossible to sell "junk" to the public, and we take considerable credit to ourselves because we believe that our efforts to distribute technical information amongst the public have contributed very largely to bring about that happy state of affairs so much in evidence at Olympia this year, where the bulk of the apparatus is above criticism technically and every stand impresses the visitor with confidence that the firm represented is a *bona fide* unit of the industry.

The Exhibition itself is larger than any Wireless Exhibition that has previously been held in this country, and the stands are more numerous; yet it is pleasing to observe that by the careful planning of the stands the organisers have been able to eliminate any impression of overcrowding in the hall. A specially constructed staircase leading from the main hall to the gallery is an innovation which has proved a most happy addition, not only from the point of view of the general appearance but because it has tended to attract the attention of the public to the gallery.

The most important innovation this year, and one on which we heartily congratulate the Radio Manufacturers' Association, is the provision which has been made in the gallery of soundproof demonstration rooms available to exhibitors. This has given the public opportunities to hear reproduction on the spot, and we hope that if in future Exhibitions space can be provided this feature may be extended so that every exhibitor can demonstrate. But we realise that with the number of exhibitors to be accommodated it was not possible for more demonstration rooms to be provided this year at Olympia. Whilst congratulating the organisers on this arrangement, we do not feel that we can be equally enthusiastic regarding the facilities arranged and the permission granted for loud speaker demonstrations in the open on every stand. There were times when in visiting the stands and conversing with the exhibitors one felt the need for a megaphone to carry on a conversation at all. We do not want to suggest that demonstration of this kind should be cut out altogether, but perhaps some arrangement could be made next year whereby a limited number of stands are permitted to demonstrate at one time.

Before passing on to our observations on the trend of technical progress we take this opportunity of extending our congratulations to the Radio Manufacturers' Association as the organisers of what is undoubtedly the finest Radio Exhibition which has yet been held.

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TYPES OF NEW RECEIVERS

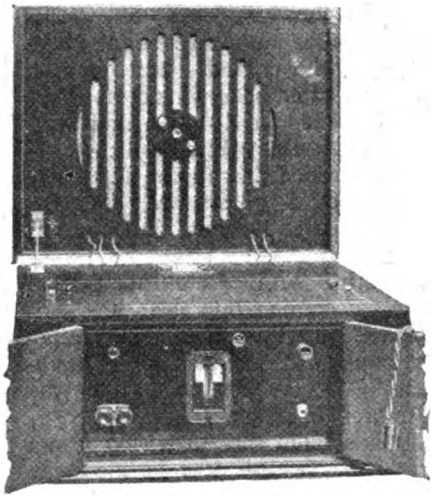
THIS has been a year of consolidation rather than of innovation. The critical visitor to Olympia finds little that is radically new, but is confirmed in the opinion that manufacturers have now completely mastered the practical application of technical developments introduced during the two preceding years—which, after all, is far more important than the adoption of novelties merely for their own sake. There has been a definite all-round improvement in quality of reproduction, sensitivity and selectivity; further, sets have been "tidied up" to such an extent that, almost without a single exception, the exhibits are entirely capable of meeting the needs of the particular type of user for whom they are designed.

It would be idle and inopportune to indulge in vain conjecture as to the developments likely to be introduced in the immediate future, and, indeed, one gains the impression that no very sweeping modification of generally accepted standard practice is anticipated. This has had an important bearing on design, as many firms have deemed it safe to embark on an extensive manufacturing programme; in consequence, a large number of sets, instead of being mere assemblies of components, are designed as units, or, where it is found to simplify and cheapen the production of several models, as an arrangement of two or more units. This procedure—provided that production is large enough in the matter of quantity—makes for economy, the saving being passed on to the consumer either in the form of cheaper sets or better sets at the same price.

Metal lends itself admirably for use in these modern manufacturing schemes, and we find that it is applied extensively; it is almost the exception to find a receiver without a metal chassis, which generally forms part of the screening system—which, by the way, is in almost every case infinitely more thorough and effective than that of last year. From this it may be concluded that much better use is being made of the properties of the screen-grid valve.

In the matter of externals it is clear that polished wood is still the most generally used material for containers. Examples of other methods of construction are not lacking; the new Amplion, Cossor, and Marconiphone (type 47) sets are typical of those housed in metal cabinets, and show the wide scope in the finish that can be given. Another method is exemplified in the Ediswan and Philips (three-valve model) sets, where a leatherette covering is applied to the metal.

Tuning control is nowadays largely effected through edgewise drums, and the conventional circular dial is seldom seen. One guesses that this is because the thumb-operated discs are considered to be more attractive to the eye and more likely to appeal to the non-technical potential user. This form

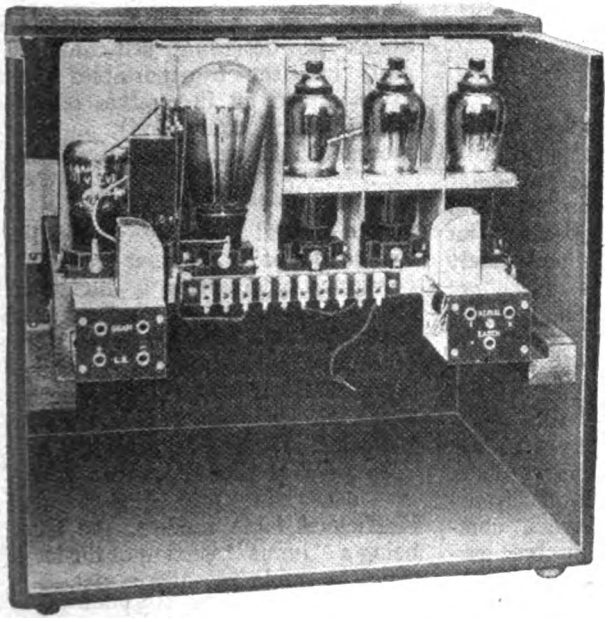


Gambrell mains transportable receiver, with frame aerial and loud speaker in lid.

of control has another important advantage: we still find that complete "ganging" of condensers is but rarely attempted (the Burndept "A.C.7" is one of the outstanding exceptions), but that the side-by-side mounting of two edgewise dials affords in a large measure the advantages of single-knob tuning. This feature is included in perhaps the majority of sets having H.F. amplification. In the Marconiphone Model 56 receiver we find an elaboration of this scheme; its four tuned circuits are permanently ganged in pairs and the two dials are mounted side by side. The Columbia five-valve set includes a similar method, but here the two sets of condensers are coupled through a slipping clutch so that they may be operated together or individually as required; this is a promising line of development.

Another minor improvement in control, found in a number of sets, is the provision of a scale arranged at a convenient angle for reading the figures.

There is a definite increase in the



Marconiphone "3-H.F." receiver, with back cover removed. Space for batteries or mains unit is provided in the base.

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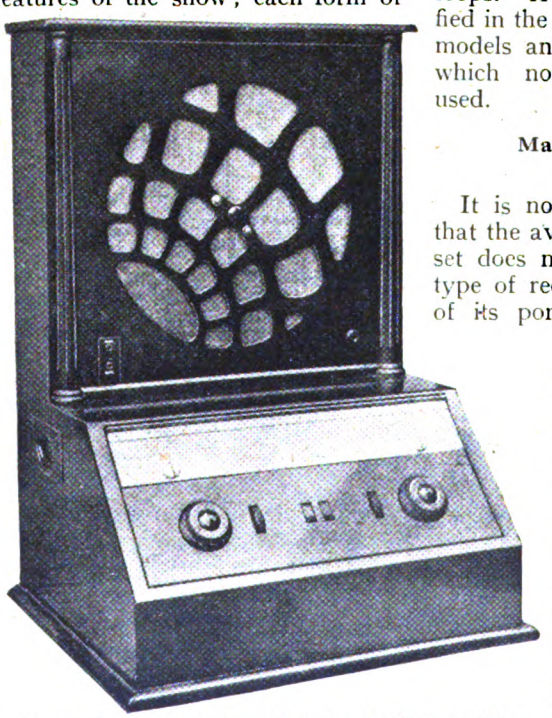
The Trend of Progress.—

practice of calibrating directly in wavelengths, instead of on an arbitrary scale. Naturally, this feature adds appreciably to the cost of production, but it is found in some quite inexpensive sets, and seems likely to be adopted to a still greater extent in the future.

Volume control methods have not undergone any radical changes, although the provision of means whereby the aperiodic aerial coupling may be critically and continuously adjusted has points of novelty; it is included in Amplion and Marconiphone sets. With regard to devices for inclusion in the L.F. side of the set, it is observed that the anode potentiometer method is widely used.

A third form of control—that of tone—is coming into use; it is embodied in the Columbia radio-gramophone, while the "Novotone" device is built into the Gambrell instrument.

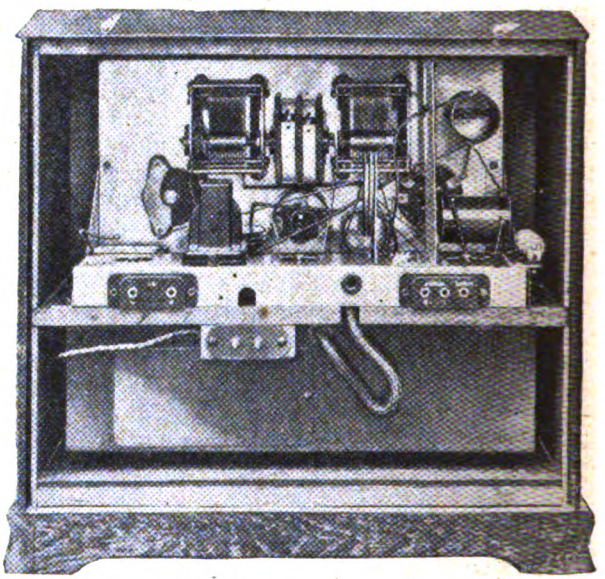
It is seldom that provision is not made for the use of a gramophone pick-up, except in the case of the simplest and least expensive type of set. As was to be expected, the radio-gramophone, complete with turntable, is one of the outstanding features of the show; each form of reproduction is, in a sense, complementary to the other, and the many excellent examples exhibited go to prove that it is not a difficult matter to combine the best features of both in a single instrument. No attempt has been made to take a census, but it is not likely to be wide of the mark to say that the majority of radio-gramophones include a built-in frame aerial which, thanks to the ample room available in the containing cabinet, is generally of sufficiently large dimensions to be reasonably effective. In several instances frames are built into flaps hinged to the sides of the cabinet, so that they may be orientated (this method is adopted by the British Radio Gramophone Company), while it is usual to provide an external knob for rotating built-in loops. A third course is exemplified in the Igranic "A.C.3" bureau models and radio gramophones, in which non-directional frames are used.



The evolution of the portable: the McMichael Table Model.

Mains Transportable Sets.

It is not an exaggeration to say that the average buyer of a portable set does not choose that particular type of receiver solely on the score of its portability, but because he wishes for a completely self-contained piece of apparatus that can be moved from room to room—and very seldom, if ever, farther afield. The truth of this seems to be generally realised, and several firms have produced mains transportable receivers, complete in themselves except for a connection to the electric supply mains. One of the first examples of this type was the R.I. All-Electric Three, which, thanks to a circuit arrangement of high efficiency, has sufficient sensitivity (though including but three valves) for average requirements without the use of any aerial. Among other interesting sets in this category are the Gambrell, Ediswan, and Lotus mains transportable models. The Burndept "A.C.7" and Igranic "A.C.3" (the latter in the bureau model) are representative in their two spheres of a different line of attack in designing self-contained sets; like the transportables they are complete in themselves (except for a mains connection), but are mounted in larger pedestal cabinets.



Interior of the Kolster-Brandes 3-valve mains set.

Table Portables.

The general tendency towards the avoidance of a number of interconnected accessories is illustrated in other directions; battery-operated self-contained sets are now being made in a form in which portability is not the first aim of the designer, who has been more concerned in evolving a set for home use. Examples of this procedure are to be seen in the G.E.C. and McMichael table models, the latter being a "home" version of the long-range portable recently reviewed in these columns. There is also a tendency towards enclosing loud-speaker and set in the same cabinet;

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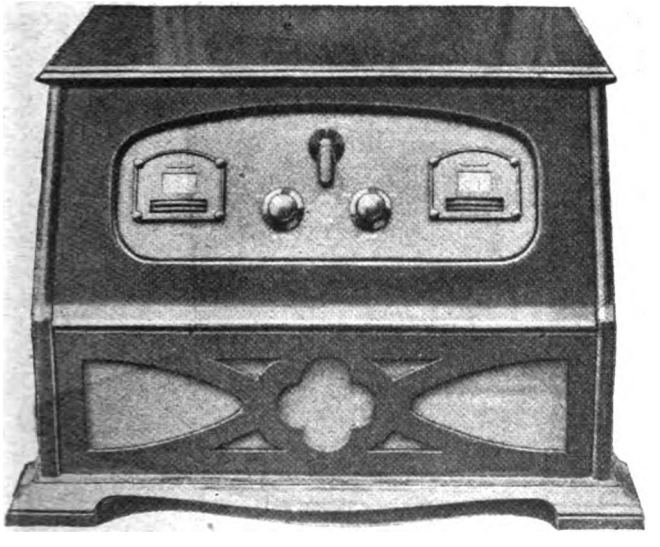
for instance, the new Cossor two-valve mains receiver is supplied in this form as well as in the conventional table pattern.

It is almost certainly correct to say that the present-day "standard" receiver is an H.F.-det.-L.F. three-valve combination with a pentode either definitely specified or optional in the last position. There are but few firms who do not produce something on these lines, but there is infinite variety in details of design. Grid-circuit detection is almost exclusively used in this class of set, but anode bend is adopted in several cases, notably in the Pye No. 350 A.C. set, which includes low-loss circuits specially suitable for working in conjunction with this type of rectifier.

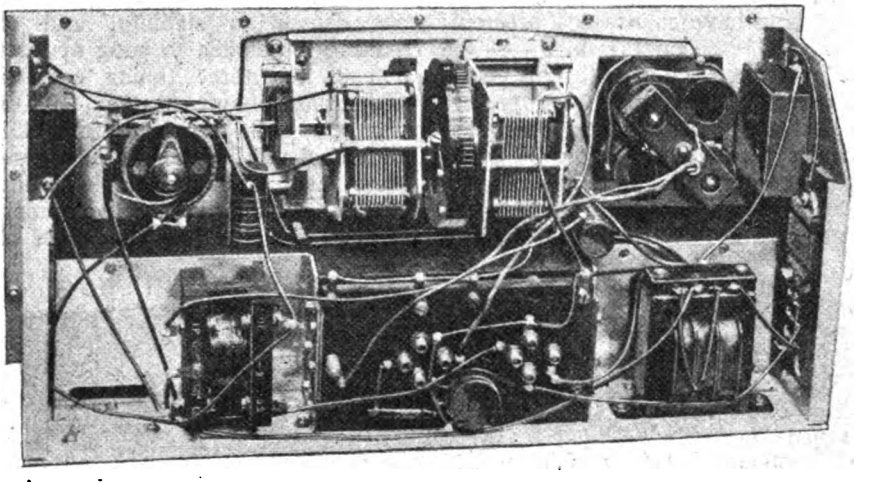
The basic three-valve circuit of the type discussed in the preceding paragraph is as popular for mains operation as for battery feed, and, thanks to the increased efficiency of indirectly heated valves, is generally quite as effective—indeed, much more effective—than the average four-valve set of a year or two ago.

Reverting to the question of detection, it is clear that the anode bend method has gained ground, but only in sets having an exceptionally efficient single H.F. stage (as the Pye No. 460), or in those with two or more H.F. stages.

There has been no great change in the L.F. amplifier except that there seems to be an ever-increasing number of sets with a single stage. In these sets there is a tendency to increase magnification by using a high-ratio L.F. transformer, such as in the new Ferranti A.C. receiver.



A good example of British design and construction: the Pye No. 350 three-valve A.C. set.



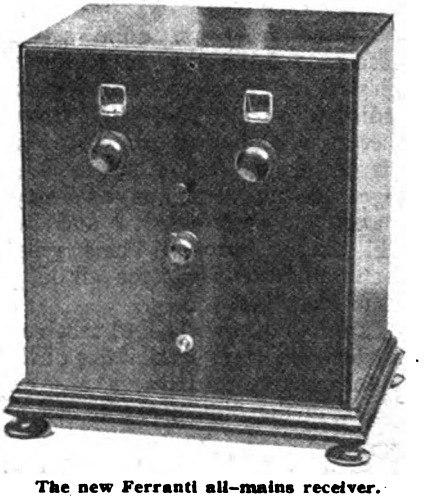
A modern portable set chassis: the McMichael portable.

It is found that practically all sets of the more ambitious type include at least some measure of decoupling, and in many cases, particularly where mains feed is provided, this refinement is included in every circuit that might conceivably give rise to interaction troubles.

In mechanical details there has been a general all-round improvement since last year; variable condensers with inadequate bearings or switches likely to develop faulty contacts after a few months' use are hardly ever seen, and almost every set should work for years without failure of its moving parts.

It has already been suggested that the outstanding feature of present-day set design is tidiness, and to this end the tendency is to include the set proper, as well as its accessories—batteries or mains unit, loud speaker, and even frame aerial—in a single container. In quite inexpensive battery sets, space for batteries is often included in the cabinet.

Although the general average of selectivity has been improved to such an extent that the requirements of the average user are adequately satisfied, there seems to be no determined attempt to cater for the potential purchaser whose letter-paper is headed, say, "Potters Bar." He is, of course, in a minority, and, commercially, can hardly be considered, although from the technical point of view it would be interesting to see what sort of comparatively simple arrangement could be devised for him.



The new Ferranti all-mains receiver.

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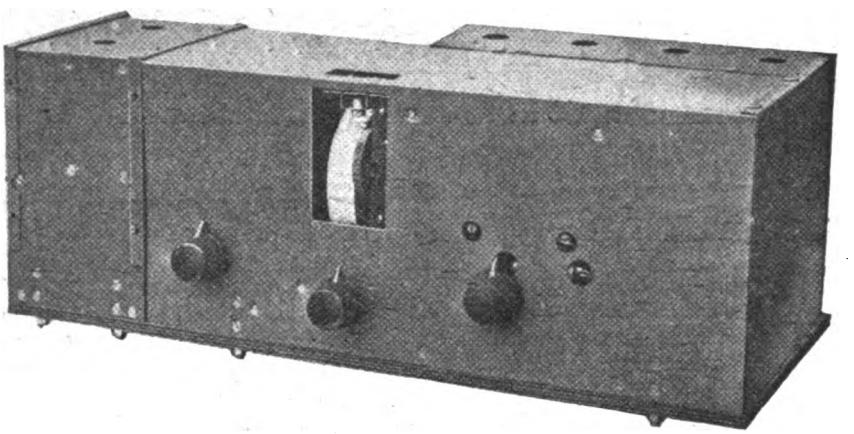
H.F. AMPLIFICATION IN MODERN RECEIVERS

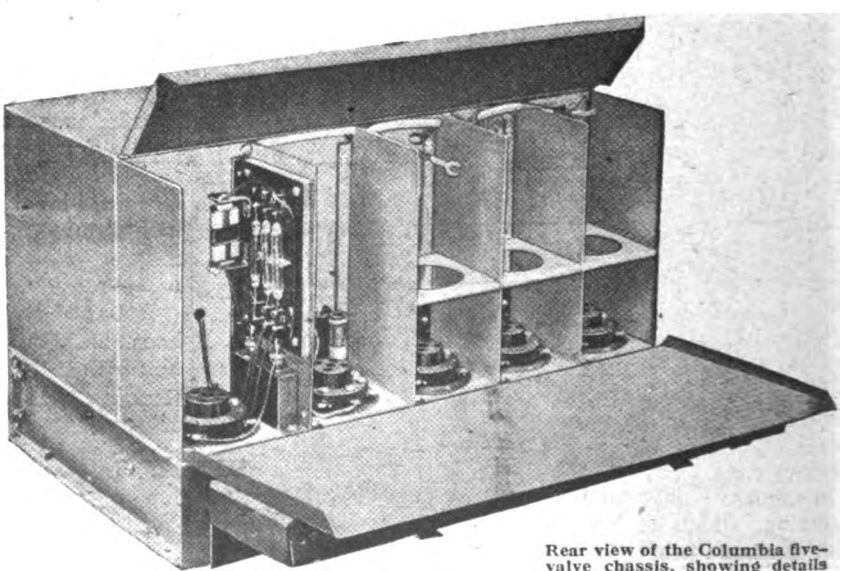
THE imminence of the regional scheme, with its twin-wave high - power transmitters, seems to have exercised a premonitory influence on the design of the high-frequency portion of this year's receivers. The need for greater selectivity that will be manifested under the new conditions is probably responsible for a general tendency to amplify more at high-frequency and less at low. Of modern four-valve receivers, quite a fair percentage have two H.F. stages followed by an anode-bend detector feeding directly to the output valve, whereas a couple of years ago one was certain to find a single H.F. stage, of very dubious efficiency, preceding a grid detector and two L.F. stages, reaction being relied upon almost entirely for all long-range reception.



The Burndept "A.C.7" chassis removed from its cabinet. This "2-H.F." set exemplifies modern tendencies in construction and screening.

Those who hope to find receivers in which the high possibilities of the modern screen-grid valve are exploited to the utmost extent will be disappointed, for a stage-gain of two or three hundred times cannot at present be attained in any design suitable for factory production. Instead of one high-gain stage many manufacturers have wisely preferred to offer two stages of moderate gain, and have thereby provided a greater degree of amplification and better selectivity than can be had, even in the laboratory, from a single stage. The higher coil losses permissible when two stages are substituted for one have the further great advantage of permitting less perfect screening without danger to stability, and of making it possible to gang at least two of the three tuning controls without loss of amplification. In this way the extra selectivity and the additional amplification of the second stage are made available while keeping a maximum of two tuning controls and avoiding all danger of losing the side-bands of the received telephony. One of the Rees-Mace portable receivers, for example, employs two tuned stages, the two intervalve transformers being tuned by a single knob, while there is a separate tuning control for the frame. It is interesting to note that for the complete screening of the H.F. stages tin-plate boxes are used, this material being chosen, we understand, because the seams of the boxes can readily be soldered up to provide the thorough screening that is so essential in a set of this type.

An interesting contrast in two H.F. receivers is presented by considering together a Burndept and a Philips set. In the former the whole of the amplifier is enclosed in a compact aluminium container which appears to provide almost perfect screening between successive stages. In the latter the use of toroidal coils has made possible the construction of an effective two-stage amplifier in which screening is practically non-existent, metal only being used in the form of a skeleton framework upon which the receiver is built. It seems probable that in this case any small stray couplings that may exist have been deliberately pressed into service to prevent oscillation instead of provoking it. If this guess is correct we have here an excellent example of the way in which the very limitations of factory production can be used as a help instead of a hindrance in the design of an efficient receiver. Both these receivers are completely ganged, there



Rear view of the Columbia five-valve chassis, showing details of the screening system.

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The Trend of Design.—

being but one control knob for all three tuned circuits.

In place of the two-position wave-band switch to change over from the medium to the long waves, the Burndept receiver employs a three-way switch. By this means the range of 200-550 metres is divided into two parts, and the variation in stage gain so often noticed in passing from one end of the medium wave-band to the other is very materially lessened by avoiding the large change in L/C ratio that is otherwise inevitable in tuning over this wide range.

Screening Materials.

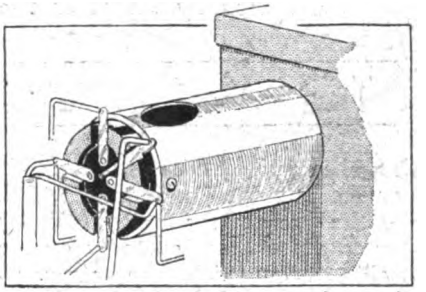
Apart from the Philips receiver just mentioned, there is noticeable a distinct tendency to use a greater amount of screening than has been customary in the past. The favourite material for the purpose is aluminium, partly owing to its lightness, and partly owing to the ease with which it can be worked. As aluminium cannot be soldered, the general custom is to make the boxes or other containers in separate sections and to build up the sections into the finished article by means of bolts. Only in cases where the compactness of the receiver, the high overall amplification, or the high efficiency of each individual stage is such as to make the most perfect screening essential are other materials preferred.

The only two receivers employing three H.F. stages both make use of what appears to be nickel-plated brass for the very perfect screening that their very high amplification demands, while in a single-stage receiver seen on the Varley stand, in which single-layer coils of thick wire are used throughout, a copper screening-box surrounds the detector grid circuit. This receiver shows a further refinement of screening, which consists of a brass tube surrounding the screen-grid valve and protecting it, as shown in the sketch, from the field of the coils. The tin-plate boxes of the Rees-Mace portable have been mentioned on the previous page.

In general one may say that screening, which a few years ago bore a shame-faced air of being a last-minute addition to stabilise an unruly set, is now so generally recognised as the prime essential of a successful high-frequency amplifier that it tends to the opposite extreme of controlling the whole lay-out of the receiver. One of the happiest examples of simultaneous design of set and screening system is undoubtedly found in the McMichael portable receiver.

The Marconiphone Co. and the Columbia Graphophone Co., the latter a newcomer to the wireless trade, both offer receivers embodying three stages of tuned high-frequency amplification. With three stages available, there is no need to make any attempt to extract the maximum amplification from each stage, so that very compact construction has been made possible. The result is a receiver in which overall selectivity should be very high indeed without danger of any loss of side-bands due to over-sharp tuning, while the overall amplification is probably better than the theoretical maximum which two stages ought, on paper, to provide. The use of astatic coils in combination with very thorough screening ensures stability, while the comparatively high losses of the coils have made it possible to reduce the tuning controls to two edgewise drums which can be rotated together with one hand. This method of attaining high amplification, though not cheap, offers a luxurious simplicity in use that cannot be surpassed by any other type of design.

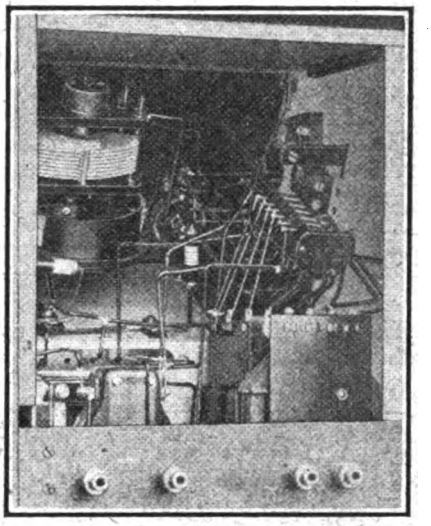
The widest choice of receivers is offered in the "1-H.F." class, of



The H.F. valve of the Varley set is enclosed in a brass tube projecting from the main screening box.

which there are very many examples. The design of the coils varies very widely from set to set, but it is interesting to note that even where coils of quite high efficiency are employed it is still considered necessary, in almost all cases, to use a grid detector aided by the use of reaction.

This suggests that the makers of



Interior of the "H.F." end of the Pye No. 350.

the sets are doubtful of the ability of their receivers to provide, with only two tuned circuits, the selectivity that will be needed when the Regional Scheme comes fully into operation, and may perhaps be taken to indicate that they expect their clients to follow the advice of the B.B.C. and reduce their aerials to quite small dimensions. With small aerials the selectivity of two tuned circuits may be expected to be reasonably adequate, while the incorporation of reaction will enable stations at long distances still to be received.

The Ediswan receiver contains single-layer coils for both aerial and intervalve tuning on the medium wave-band. The fact that the aerial coil is wound with stranded wire suggests that the receiver is intended either for use with quite a small aerial, or with a very loose aerial coupling, as otherwise the benefits conferred by this expensive form of winding would not be evident. It was difficult to follow out the switch wiring, but it appeared that a loading coil was used for the long waves, being shorted out on the medium wave-band. In the Pye three-valve set, on the other hand, two entirely separate high-frequency

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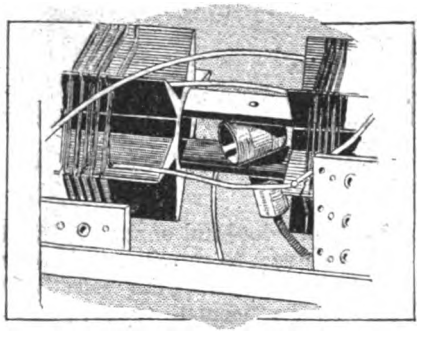
The Trend of Design.—

transformers, with a complete switch-over of all connections, have been preferred. A photograph indicates the extreme neatness of the arrangement, and shows the arm that goes through the screening-box to gang the aerial-circuit switch with the intervalve-circuit switch that is actually shown. The only definite data for stage-gain that was offered us, on any stand, referred to this receiver. The amplification for the medium-wave band is given as 96 times, with 160 times on the long-waves.

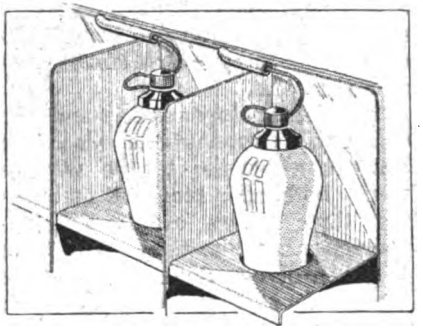
In the Ferranti three-valve receiver the coils used are wound in slots in a ribbed ebonite former as shown clearly in the sketch.



H.F. transformers in the Ferranti set, showing mounting of the reaction coil.

Readers of *The Wireless World* will hardly need to be reminded that high-frequency transformers constructed on these lines offer many valuable advantages when used with screen-grid valves.

Binocular coils do not appear to have received much attention, though they are in evidence in a McMichael set which, with only one high-frequency stage, is recommended for use with a frame aerial. The ingenious method in which one pair of reaction coils (one coil being coupled to each half of the binocular



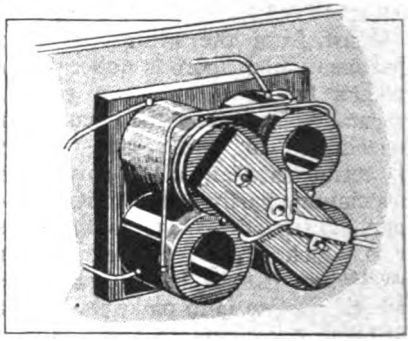
H.F. valve mountings in Marconiphone Model 56 set. Screening tubes are provided for the anode leads.

pair) is made to do duty on both wave-ranges is indicated in the accompanying sketch.

The comments so far made have been applied impartially to all sets, whether tuned anode, tuned grid, or tuned transformer circuits have been adopted. The simple tuned anode is giving place, by degrees, to its more elaborate rivals, both of which offer advantages in lessening inter-stage coupling. In the cases where transformer coupling has been adopted, it has usually been preferred for the sake of the extra selectivity that, at the cost of a small decrease on amplification, it can be made to yield. Tuned anode circuits are, on the whole, mainly to be found in receivers with but one stage of high-frequency amplification, while the decoupling advantages offered by the other two circuits have made them the favourites where more than one stage is employed.

Untuned couplings are chiefly to be found in the portable receivers, where the use of a frame makes up for an extreme lack of selectivity in the amplifier itself. A very useful compromise, offering an increase both in signal strength and in selectivity, is found in many portables which have one tuned and one untuned stage.

Even the briefest survey of the receivers offered at this year's Show makes it very clear indeed that the bad old days when the high-frequency stages were included



Assembly of medium and long-wave binocular anode coils in the McMichael portable. Swinging reaction coils are mounted on a pivoted block.

merely as a selling point, with no real hope that they would contribute anything to the amplification of the receiver, are past and over. Though one could not say that every amplifier comes up to the standard of the best on view, there is certainly none that fails to contribute a very considerable share to the performance of the set into which it is built.

OPERATING FROM THE MAINS

THE majority of the listening public have yet to appreciate the success which attends both long range and quality reception which has been brought about by the remarkable progress revealed during the past few months in valve manufacture. Makers of sets are emphasising the outstanding quality of reception combined with an ability to receive distant stations, coupling with these claims the merits of "all-mains" working. It is this last observation which is responsible for the improved performance, first by the use of the new indirectly heated valves, and secondly by the facility with which the comparatively heavy H.T. demands of a generous output stage are obtained from the mains.

To the statement "mains operated" so freely announced at the stands must be added the initial letters "A.C." Whereas at last year's exhibition there were more D.C. than A.C. mains-operated sets there are now comparatively few D.C. models.

With the comforting remark that the D.C. supply is shortly to be substituted by A.C. the manufacturers have shunned the problem of the D.C. mains-operated set and at the moment are congratulating themselves on having achieved the almost unexpected and outstanding results given by the A.C. equipment.

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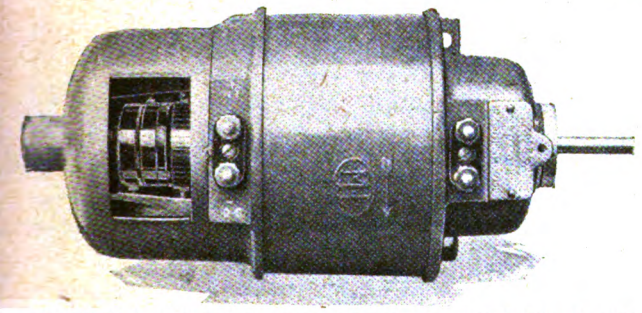
The Trend of Design.—

There are exceptions among the exhibits of the mains-operated set manufacturers of previous years, where D.C. as well as A.C. sets are still to be found. On the other hand, the majority of the exhibitors of "all-mains" operated sets, such as Philips, Ferranti, Colvern, Cossor and many others, provide exclusively for A.C. supply. With the fairly reliable estimate of three to five representing the ratio of D.C. to A.C. mains supply the scarcity of D.C. equipments is significant. Had there been a mains valve taking a current appreciably less than 0.1 amp. and a potential approaching that of the normal D.C. supply voltage there is no doubt that D.C. mains equipments would have equalled in numbers those designed for A.C. supply. The listener who has D.C. supply is disappointed. Any of the A.C. mains-operated sets can, however, be used with D.C. supply with the aid of a small D.C. to A.C. rotary converter. Such a machine has been developed by the M-L Magneto Syndicate, Ltd. This machine is of the double-wound armature type and, like M-L generators, has a permanent magnet field. The A.C. output is 40 watts.



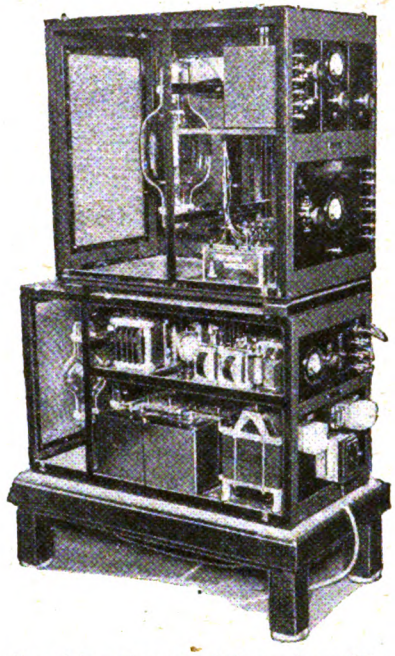
Small M-L alternating current generator, permitting the use of A.C. mains receivers with D.C. supply.

Another machine of interest to those with D.C. supply is one arranged to step-up the mains voltage to 500, thus affording a solution to the problem of operating generous output valves with a modest mains potential.

In design, the A.C. mains-operated sets possess little novelty. A transformer produces the potentials required for a metal or valve rectifier, heater current for the indirectly heated valves, as well as A.C. filament current for an output valve; while in some instances an additional potential is provided for a grid biasing rectifier. It is the exception rather than the rule to fix the available anode potential at a maximum of 150 volts, as was the case last season. Rectified potentials of 250 volts are common, brought about by the use of such output valves as the P.625, P.625A, and the P.T.625, while in more than one receiver of the popular class the anode potential approaches 300 volts to suit the new pentode valve, the P.M.24A. An even division roughly exists in the sets shown between the use of metal and valve rectifiers.

Grid Biasing Methods.

Examples of the three common methods of obtaining grid biasing in the A.C. mains-operated set are to be found. In order of popularity these are: (1) "free" grid bias produced by a voltage across a resistance which is traversed by the anode current; (2) a separate rectifier, and (3) the use of a potential divider across the H.T. supply. The first is favoured because of its small cost and its freedom from the complications of unwanted couplings. Like the potentiometer arrangement, this method results in a reduction of the maximum anode voltage, grid bias being obtained by robbing the H.T. potential. The potential thus taken is not accompanied by the drawing of a supply of current that is made available by the high voltage rectifier. Method (2) is invariably carried into effect by the use of the special Westinghouse rectifier produced for the purpose. The merit of this arrangement is complete separation of grid and anode circuits. The potential divided method (3) is only adopted when the various anode potentials required in the receiver are produced by means of a potentiometer. This third method is, where necessary, associated with the use of feed resistances to avoid couplings between the several valve stages. Several of the A.C. mains-operated sets are fitted with grid biasing cells. It is the low cost of the grid cell as compared with other biasing devices that accounts for its continued use. The inclusion of cells in mains-operated receivers is to be deprecated, on the grounds that a loss of voltage is only discovered in consequence of a falling-



Complete mains-operated speech amplifier for public address purposes developed by Partridge and Mee.

off in performance. When this point is reached the valves will almost certainly have suffered damage by being operated at the full anode potential maintained by the eliminator.

A departure from the established practice of last season, when manufacturers were opposed to the use in home equipments of voltages much in excess of 200, is the provision in several sets in the radio-gramophone class of anode potentials of the order of 500 volts. These outfits are, of course, essentially designed for hotel and cinema work. A notable change among the large mains-operated installations for public address purposes is the substitution of a single high-powered valve in the place of a parallel-connected group. It is invariably the practice to build a high voltage rectifier associated exclusively with the output stage when the speech output exceeds more than a few watts.

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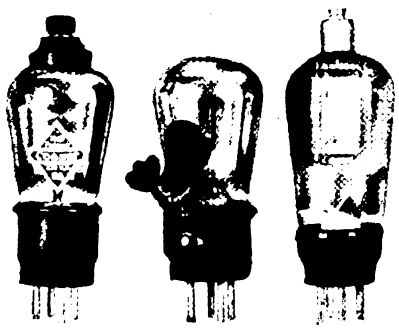
VALVES OF TO-DAY

PROGRESS in receiver design is almost entirely dependent upon valve development, as witness the abundance of all-mains receivers at Olympia this year—an advance following close on the heels of the A.C. valve which has only lately been *generally* obtainable from the group of well-known valve makers. Valves with indirectly heated cathodes have suffered from a serious defect—namely, grid emission—but a cure has been found and applied, with the result that this year is being known as an "all-mains year," so quickly does receiver technique respond to the influence of the valve.

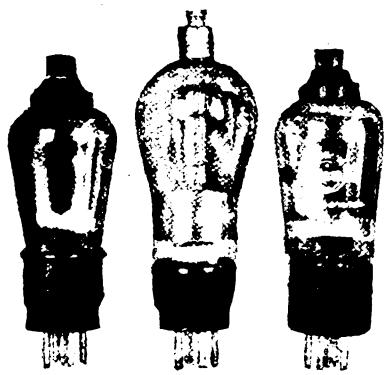
Last year saw the introduction of the pentode, which has now consolidated its position and is to be found fitted as standard in many sets, especially portables, where space considerations demand the minimum number of valves and couplings. There are many new pentodes available, amongst them a type capable of enormous output when using 300 volts H.T. and having a filament suitable for direct A.C. heating. Hitherto the low maximum permissible anode voltage somewhat restricted the output, and incidentally the input of the pentode.



A B C

Three typical battery-fed screen-grid valves. (A) Mazda 215 S.G. The anode-grid capacity is 0.005$\mu\mu$F; a stage gain of about 150 is possible (unneutralised). (B) Cleartron S.G. valve with anode terminal in base and press-button connection. (C) Cossor 220 S.G.

Screen-grid valves for battery heating have been improved to such a degree that it is now possible to make the definite statement that, with a simple coupling, a stable amplification is obtainable up to four times that possible with the best neutralised three-electrode valve. The demise of the latter is, therefore, complete. The universal adoption of the screened valve where H.F. amplification is used not only makes for considerably greater stage gain, but there is also the advantage of simple waveband switching and the application of reaction without aerial reradiation.



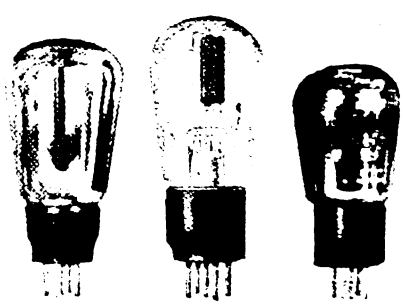
D E F

Indirectly heated screen-grid valves for A.C. mains. (D) Cossor MSG41 with a slope of 2 mA./volt. (E) Mazda AC/SG with which the remarkable stage amplification of about 250 (unneutralised) can be attained. The inter-electrode capacity is 0.0045$\mu\mu$F. (F) Mullard S4V with an amplification factor of 1000.

Perhaps the most striking addition to the enormous range of valves now available is the series of indirectly heated screen-grid valves with remarkable constants. There are four such valves at the moment on the market with which a simple coupling coil can be used and stable amplifications up to nearly 250 times, or about six times that of the best possible neutralised triode, are possible. Before discussing specific cases of valve design, tribute must be paid to those manufacturers who have developed the 2-volt three-electrode valve, so that its characteristics for a given filament wattage are as good as, and in some cases better than, those of similar 6-volt valves. Reference is here made to the new 2-volt battery valves with mutual conductances approaching 4 mA. per volt—a great achievement.

It is understood that the popularity of 2-volt valves in general is such that their output from at least one well-known factory is considerably greater than all other types put together. This can be accounted for by the big demand for such valves for portable receivers and for home sets where the L.T. accumulator has to be carried to the charging station. Little advance appears to have been made with directly heated A.C. valves with fat, short filaments for A.C. potentials below 1 volt. They may confer the slight advantage of easier wiring, but there appears to be no directly heated model which has not got an indirectly heated counterpart with substantially better characteristics, and there is no advantage in price. There is a welcome standardisation of valve bases and holders for all A.C. valves, the fifth contact being centrally disposed on the base. It is understood that all pentodes will fall into line with this arrangement in due course; at present there are only one or two to be found without a side terminal.

Referring again to A.C. valves with independently heated cathodes, it has apparently needed a great deal of research to combat the evil of emission taking place from the control grid—a condition which is worse in its effect in a receiver than the copious flow of grid current. It is almost impossible to prevent the coating of the cathode from finding its way to the grid, but the problem of avoiding a sufficient temperature rise to prevent the grid from emitting has been tackled particularly by the Metro-Vick research department, and the fruits of their labour are



G H J

Indirectly heated triodes. (G) Mazda AC/HL with a slope of 2.6 mA./volt. (H) Marconi MH4 valve. (J) Mullard 354V with an amplification factor of 35 and a slope of 2.5 mA./volt.

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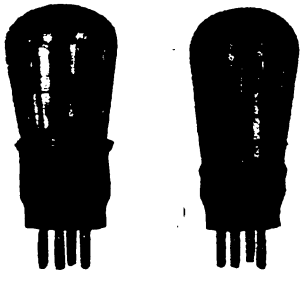
The Trend of Progress.—evident in the present range of Mazda A.C. valves. In the first place, instead of a separate heater and insulator, the heater is dipped into porcelain "slip" so as to be coated with an adherent insulator. This produces a cathode of small diameter and considerable length, resulting in the watts dissipation per cm. being small, thus maintaining a cool grid. To allow for any small heat radiation from the grid, a number of A.C. valves also have open or ventilated anodes.

Where lighting mains are available, there is a great advantage in using A.C. valves, not only because of the cheaper and constant voltage supply, but also for the reason that, compared with battery valves, a

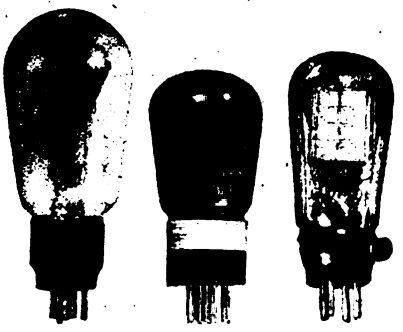


K L

Directly heated A.C. valves. (K) Osram D8. A special detector consuming 1.6 amps. at 0.8 volt. (L) Cossor 82.MD.

better mutual conductance and hence performance can be obtained. The A.C. valve does not suffer from a potential gradient down the filament, as it has an equipotential surface and there is no field around it tending to restrict electron flow.

Including the four A.C. screened valves already referred to, there are at present about nineteen indirectly heated valves marketed. The Mazda AC/HL is an improved AC/G with an A.C. resistance of 13,500 ohms and an amplification factor of 35; the AC/P has a mutual conductance of 3.75 mA./volt and an A.C. resistance of 2,650 ohms, while the AC/P1 is a super-power output valve having the high amplification factor of 5 and an A.C. resistance of 2,000 ohms, and is capable of delivering at 200 volts H.T. 1 watt of undistorted A.C. output. This is accepted as being adequate for a moving-coil loud speaker for any ordinary domestic purpose. The Marconi and Osram MHL4 has the necessary characteristics for an anode bend detector, and will accept up to about 25 volts grid swing

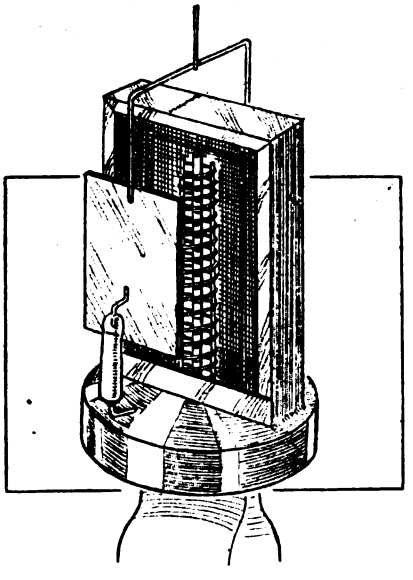


M N P

Typical pentodes. (M) Osram PT 625 for anode voltages up to 250. (N) Mullard PM24A for 300 volts H.T. (P) Mazda 230–Pen. The outer grid is connected to the control grid as a safeguard.

when the high-tension voltage is 200. With an A.C. resistance of 8,000 ohms and an amplification factor of 16 it would be permissible to link such a detector to an L.F. transformer of high primary inductance. The ML4 is a power output valve with a slope of 2 capable of accepting about 45 volts grid swing with 200 volts H.T.

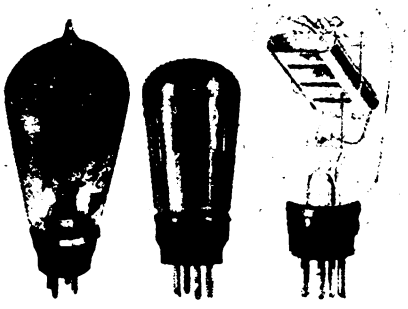
Of the Mullard A.C. valves, mention should be made of the 164V, which has the characteristics of the well-known steep slope "D" valves, but an even better mutual conductance of 2.4 mA./volt. The



The electrode disposition in the Marconi M.S.4—the S.G. valve for A.C. mains. The interelectrode capacity has been reduced to 0.0045 $\mu\mu$F by the use of a cross-mesh screening grid. A stage amplification of nearly 200 with stability is possible (unneutralised).

power output valve of this series—the 104V—has the remarkable slope of 3.5 and an A.C. resistance of 2,850 ohms. There are no fewer than five Cossor A.C. valves (other than the S.G. valve for A.C.) having A.C. resistances from 2,000 to 20,000 ohms.

As for screen-grid valves, about a year ago it was not possible to obtain a stage amplification greater than about 80 before instability set in, however perfect the screening in the receiver might have been. By a careful investigation of the effect of two screening grids in cascade or by using a cross-mesh screen, it has been found possible during the last year to reduce the interelectrode capacity to the extremely low figure of 0.0045 micromicrofarads, allowing single-stage amplifications up to 250 with stability and without neutralisation. The Mazda 215 S.G., the AC/SG, and the Marconi and Osram MS4, have capacities of about the figure mentioned. With low-loss circuits it is the valve capacity which limits the amplification possible before oscillation commences. As an example let us take the Mazda 215 S.G. with a capacity of 0.005 $\mu\mu$F; the maximum attainable amplification (unneutralised) is about 150; if the capacity had been 0.05 $\mu\mu$F—a figure not unknown quite a short time ago—the maximum amplification would be 60, or hardly any more than that of the much cheaper triode.



Q R S

Power output valves. (Q) Osram LS6A giving a very large power output. (R) Mazda P.240; a 2-volt battery valve with the remarkable slope of 3.7 mA./volt. (S) Marconi PX4; a new 4-volt power valve.

A very controversial point now arises. With such meticulous care to avoid the very minutest loss due to valve capacity, it would seem incongruous with valves for H.F. cir-

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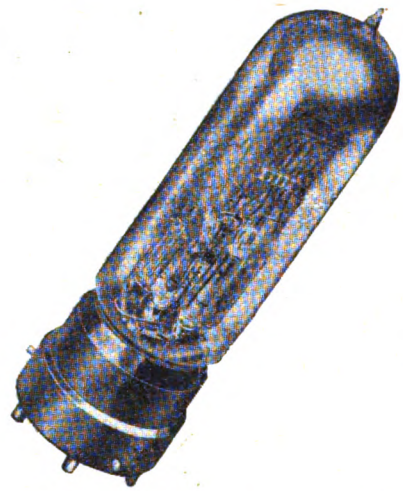
The Trend of Progress.—

cuits to use an ordinary valve base and valve holder, which together add a minimum of about 500,000 ohms (at 300 metres) in shunt with the dynamic resistance of the tuned circuit. If the latter is of the Litz low-loss type with a dynamic resistance of possibly 300,000 ohms, as soon as the valve and holder are put in circuit the impedance drops to 188,000 ohms, or a little over half its original value. A decapped valve acts as a shunt of about 5 megohms and has a negligible effect. Will a new method of mounting valves for H.F. circuits be seen during the coming year?

With regard to special detectors, beyond the indirectly heated "D" valves there does not appear to be any newcomer. A screened valve with an A.C. resistance not above 20,000 ohms would find a large field of application for aperiodic coupling in portable sets and for anode bend detection.

Readers may have been wondering why with each new range of valves the leaky grid detector of the series becomes more sensitive. This method of detection depends upon the bend in the grid current curve, which is bound up with the question of emission velocity from the filament. In its turn this is affected by the working temperature, and herein lies the explanation. Successive oxide-coating processes have resulted in lower and lower filament temperatures, and if one of the new valves be compared with a former type—each having the same A.C. resistance and amplification factor—the greater sensitivity of the new valve with the lower working temperature will be most marked.

There is an abundance of pentodes this season. In spite of the theoretical disadvantage of disparity



Loewe multiple valve (triple) containing detector with contact for reaction and two resistance-coupled L.F. stages.

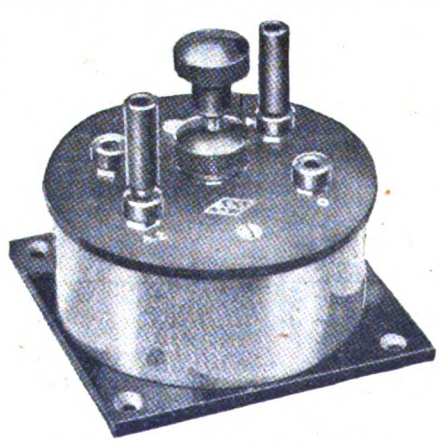
of impedance relationship between loud speaker and valve, the results obtained without any output coupling device are often very brilliant and pleasing, this effect being probably due to the pentode and loud speaker combination having a greater response to the high notes which may have easily been suppressed earlier in the receiver. Pentodes suffer from the disadvantage of running into anode distortion before the available grid base is used; in this connection a welcome addition to the range is the Mullard P.M.24A for use with 300 volts on the anode and 200 volts on the auxiliary grid. Very large power outputs are possible before anode curvature distortion starts. The new Mazda pentodes (230-Pen and 425-Pen) contain an outer third grid which is connected to the control grid and not to the filament in the conventional way. In the event of the outer grid touching the anode, all the valves in the receiver are saved from destruction. Particularly efficient are the new Marconi and Osram pentodes with 2-, 4- and 6-volt filaments having slopes ranging from 1.65 to 2. The 6-volt member—the PT625—will deliver a very large undistorted output with 15 volts negative bias, 250 volts on the anode, and a maximum of 200 volts on the screen-grid.

Mutual conductance which is synonymous with a figure of merit for L.F. valves has been improved considerably; the Mullard P.M.256, for instance, has a conductance of 3.25 mA. per volt, the figure for the Marconi and Osram P.625 is 2.5, and those for the new 2-volt Mazda output valves—the P.220 and P.240—3.4 and 3.7 respectively. Thus there is now little need for more than one valve between the detector and the loud speaker.

ACCESSORIES OF INTEREST

UNDER this heading we may include all those pieces of apparatus, such as loud speakers, batteries, and gramophone pick-ups, which may be considered as external adjuncts to the receiving set proper. While they do not rank as components in the same sense as condensers and valves, they are none the less essential to the completion of any wireless equipment.

The manufacture of accumulator batteries had reached the stable state long before the advent of broadcasting, and one does not expect to find in this quarter any changes of a revolutionary character. Of the



B. & J. rejector unit with Litz-wound coils.

numerous types of battery produced specially for radio work, the greatest activity would appear to be among unspillable cells for portable sets and large-capacity "mass" type cells for sets using the popular 2-volt series of valves.

In spite of the enormous increase in mains-operated sets, the dry cell H.T. battery continues to hold its own. The fact that a firm of long experience in the wireless industry is marketing H.T. batteries as a new line this year may be taken as an indication that this much maligned but none the less convenient source of H.T. will survive for many years to

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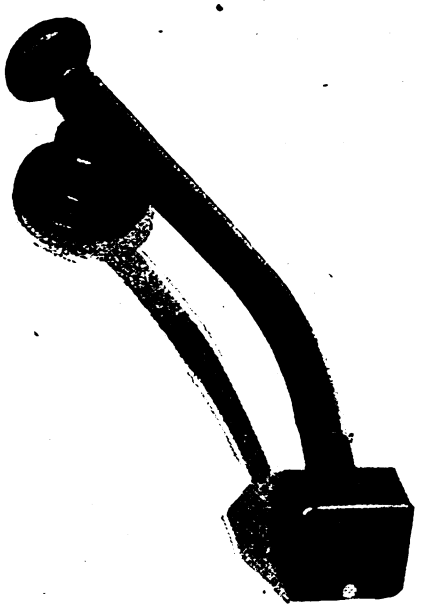
The Trend of Progress.—

come. The demands of the portable set and of people living in remote country districts are sufficient to ensure this.

In view of the immediate necessity of improving the selectivity of out-of-date receivers to cope with the new Regional station, one might have expected to see more rejectors and



The new Marconiphone pick-up and tone arm.

selectivity units for attachment between the aerial and the set. With one or two notable exceptions, manufacturers in general do not seem to be alive to a demand which is likely to be felt during the next few weeks for accessories of this type. The few rejector units on view, however, are well designed, and in most cases are wound with Litz wire to ensure a high value of H.F. current in the closed circuit. It is interesting to note that the New London Electron Works, Ltd., are marketing a 50ft. length of aerial wire in accordance with the suggestions put forward in a recent B.B.C. pamphlet on the subject of selectivity.

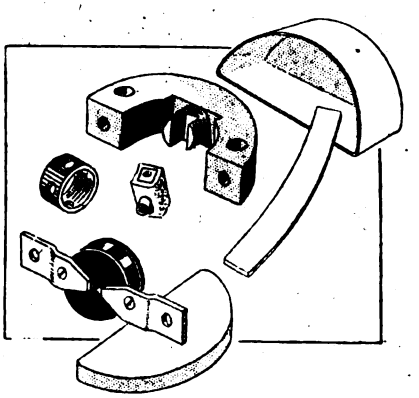
Lissen needle armature pick-up and moulded tone arm.

Gramophone attachments for the electrical reproduction of records are among the most important accessories of the modern radio receiver. This year we are able to report a very marked advance in the design of electrical pick-ups, not only as regards frequency characteristics, but also in the matter of record wear and needle track alignment. In all the leading makes the pick-up is mounted at an angle with the tone arm. By fixing this angle in relation to the length of the tone arm and the position of the tone arm pivot, it has been

Burndept needle armature pick-up and tone arm.

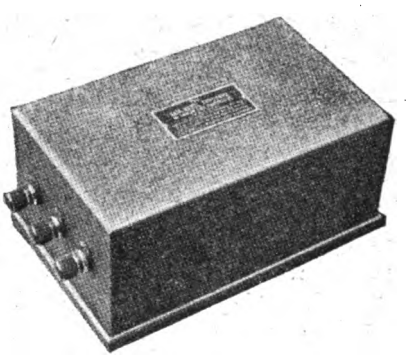
found possible to reduce tracking errors to within 2 or 3 per cent.[1] The improved tracking in conjunction with a general lightening of the moving parts and a reduction in the degree of damping, have reduced record wear almost to vanishing point. Tests have proved that with modern pick-ups it is possible to play a record more than two hundred times before the first traces of wear are apparent, while the useful life in practice is considerably more than this.

The influence of the standard frequency records recently issued by the Gramophone Co., Ltd., is to be observed throughout the Exhibition.



Component parts of the Burndept pick-up.

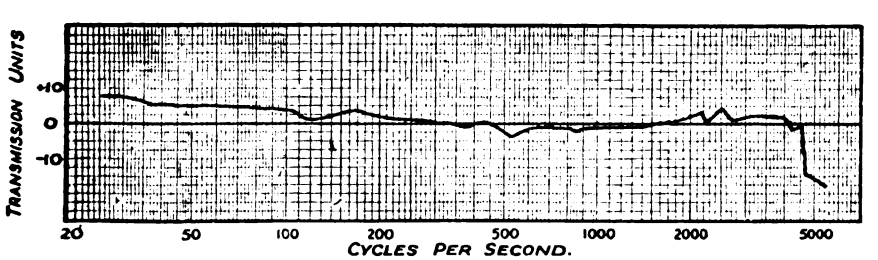
Even if frequency characteristics are not published there is evidence that all the leading makers are using these records in their design departments, and that empirical methods of development are giving place to exact measurement. One of the first conclusions to be forced on the notice of designers is that the mass of the reed or armature has, in the past,



Gambrell "Novotone" tone correction unit.

been far too great, with the result that a nasty resonance has appeared within the range of fundamental frequencies used in speech and music. Consequently, we find this year that the successful pick-ups employ reeds

[1] See *The Wireless World*, August 7th, 1929, p. 132.



Characteristic of the new Marconiphone pick-up.

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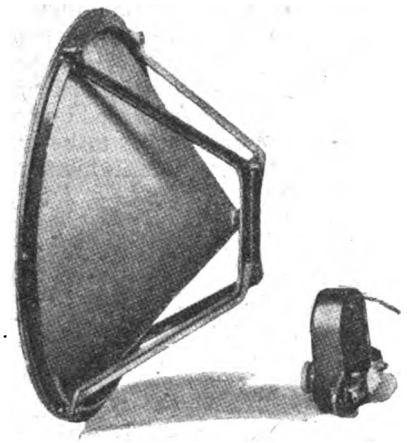
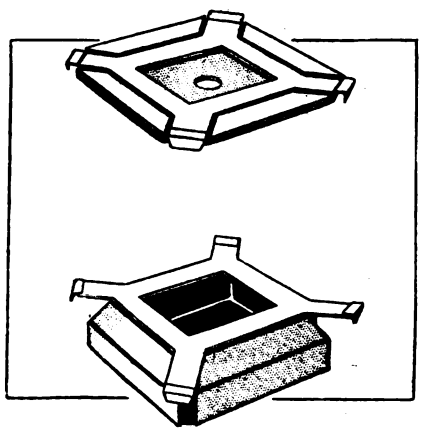
The Trend of Progress.—
of microscopic dimensions; the modern pick-up and its moving parts are now reduced to the scale of a wrist-watch.



Brown "Vee" unit and cone chassis.

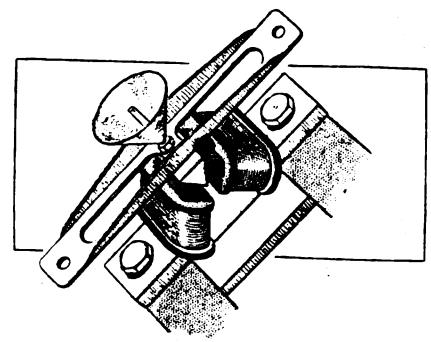
The new Burndept "Needle Armature" pick-up is illustrative of the trend of pick-up design. Its small dimensions and graceful design may be judged from the accompanying photograph. The needle itself forms the armature and carries the magnetic flux; there is no moving part other than the small clamping screw and boss. The output is comparatively small, but the frequency characteristic is practically perfect and does not show more than a two-decimal variation between 125 and 6,000 cycles. Below 125 cycles there is an increase in the output to compensate for the restriction in amplitude of the low notes on the record.



Baker "Selhurst" parallel action centring device.

The Lissen pick-up also works on this principle, but dispenses with the set screw. The needle is embedded in a block of rubber, from which it can be easily withdrawn and replaced. The general level of output is of the order of 0.4 volt R.M.S.

Finally, there is the new Marconiphone pick-up, in which an excellent frequency characteristic has been achieved without dispensing with an armature, though this has been reduced to exceedingly small dimensions. It is significant that this pick-up has been developed in conjunction with the Gramophone Co., Ltd., and is one of the first products of the amalgamation. Obviously no one is in a better position to know the type of characteristic required in a pick-up than the makers of the records, and it is safe to assume that the characteristics of this pick-up may be taken as a standard for comparison.



Sketch showing the principle of the Brown "Vee" unit.

While on the subject of gramophone accessories, mention should be made of the "Novotone" filter unit. This instrument is connected between the pick-up and the amplifier, and, while compensating for high- and low-note loss, also raises the general level of the voltage output from the pick-up by about four times. A good modern pick-up does not require any correcting device, but the same cannot be said of the overall characteristics of an electric gramophone including the amplifier and loud speaker. The fact is that the "Novotone" does effect a remarkable improvement, which has been convincingly demonstrated.

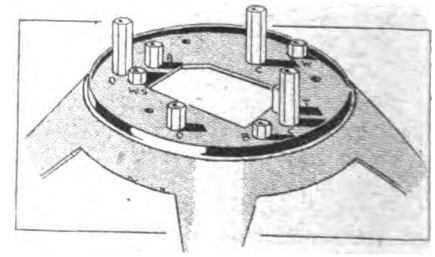
No new principle in loud speaker design has appeared in practical form. The field is still divided between the moving coil and balanced armature types, and numerous detail refinements are evident. The general trend is towards the production of "chassis" units ready for assembly

B.T.H. cone unit with concentrically corrugated diaphragm.

in a pedestal cabinet together with the remainder of the radio and gramophone equipment. In other words, the loud speaker must now be regarded as a component rather than an accessory.

Considerable ingenuity has been displayed in the design of vibrating reed and balanced armature movements, and a large variety of units of every conceivable type are now available at competitive prices.

Among complete cone units incorporating reed and balanced armature movements are the Brown Vee unit and the B.T.H. cone unit assembly. The latter equipment comprises a cone chassis in which the diaphragm is provided with concentric corrugations. These corrugations facilitate the formation of nodes so that the effective diameter of the dia-



Baker "Selhurst" universal cone chassis.

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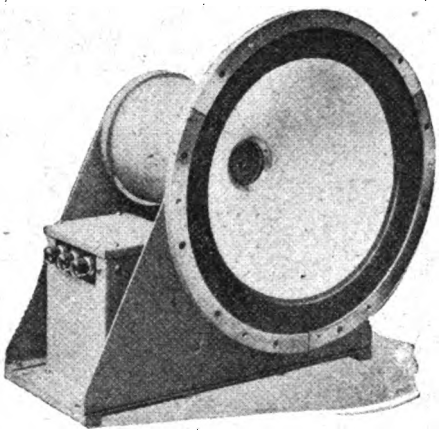
The Trend of Design.—

phragm automatically adjusts itself to the frequency applied by the drive. At low frequencies the whole of the diaphragm is set in motion, while at high frequencies only the centre of the cone near the apex is in action.

Messrs. Baker's "Selhurst" Radio have produced a Universal cone chassis, the frame casting of which is provided with a series of holes and raised lugs which are tapped to fit the majority of balanced armature movements on the market. Another ingenious development exhibited by this firm is the parallel-action centring device incorporated in the 1930 "Super Power" moving coil loud speaker.

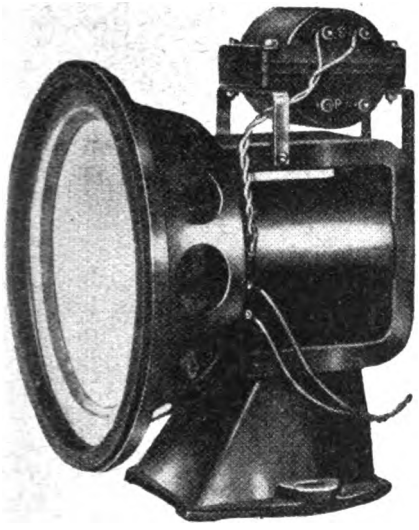
The policy of "chassis" construc-



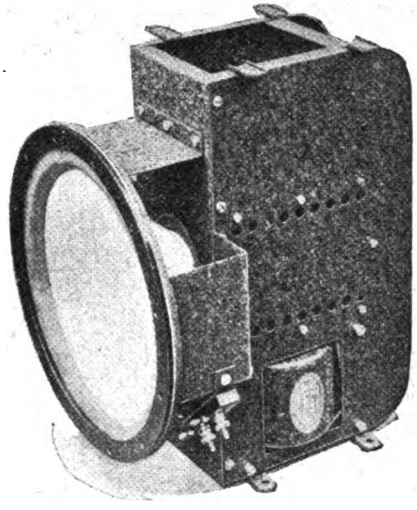
G.E.C. moving coil loud speaker unit.

tion has also extended this year among makers of moving coil loud speakers. Messrs. Kolster-Brandes, Ltd., and the G.E.C. are among the firms showing this form of construction for the first time. The production of a moving coil unit is also a new departure for Messrs. Ferranti, Ltd. This unit is beautifully constructed and incorporates a valve rectifier for energising the field magnet from A.C. mains; full details of the flux density, etc., are given in the report in the previous issue.

In view of the success of last year's Marconiphone moving coil loud speaker, considerable interest attaches to the redesigned model for 1930. The cone diameter has been reduced and the centring "spider" is now omitted, giving a much more compact and robust form of construction. The production costs have also been reduced, but the quality of reproduction maintains the high standard of the previous model. We have heard the new model in operation, and it is evident that while the sensitivity to weak inputs is quite equal to the old model, the power handling capacity has been considerably improved.



Redesigned Marconiphone moving coil unit.



Moving coil unit for A.C. mains—a new product of Messrs. Ferranti Ltd.

NEW COMPONENTS SEEN AT OLYMPIA

IN a review of the components shown this year we find that the tendency is in the direction of improvement in quality rather than in quantity. This is evidenced by the increase in the number of manufacturers now supplying precise details of the performance of their wares under varying conditions of use. Information of this nature is becoming more and more essential to the set manufacturers, as well as to the home constructor, because it is only by a knowledge of the performance of the component parts that a high standard of reproduction can be attained in the complete receiver. We see, therefore, curves and figures displayed showing the impedance of such components as H.F. chokes at different frequencies. The "Dual Astatic" H.F. choke of R.I., Ltd., is a case in point. Furthermore, this component is astatically wound, so that the external magnetic field is kept within reasonable bounds. The Eddystone version is now accompanied also by a curve showing its impedance at different radio frequencies.

Information of a similar nature is being given by makers of L.F. chokes. With the ordinary type the inductance changes with the value of the steady current passing through its windings, due to the influence of ampere turns on the permeability of the iron. The Wearite choke does not suffer any appreciable change in inductance between fairly wide limits of current value, this feature being emphasised in the family of curves published for their range of constant inductance L.F. chokes under different conditions of working. Another example is the Varley constant inductance choke. A value of 20 henrys is maintained when carrying D.C. currents of from 1 to 100 mA.

The several improvements made in valve design, particularly as regards super-power valves, have brought into being some additions to the range of heavy-duty output chokes. A typical example of modern practice is reflected in the Pye No. 687 model.

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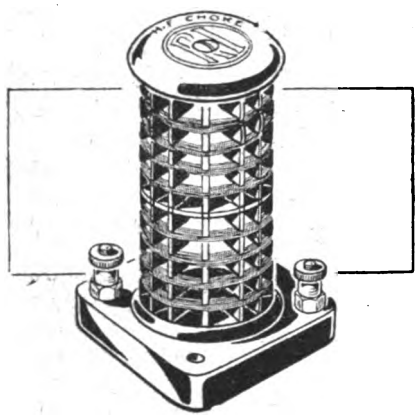
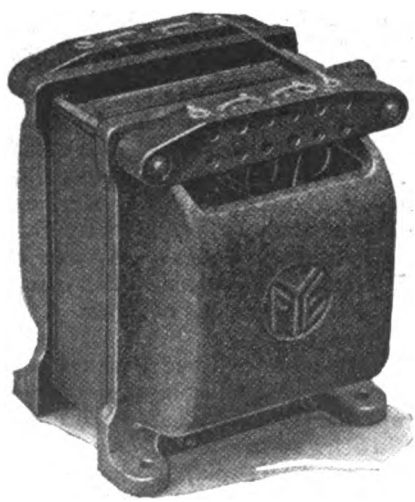
The Trend of Design.—
Sectional windings are employed, the ends being brought out to sockets mounted on a strip of insulating material. The sections may be connected in a variety of series-parallel arrangements, and thereby enable inductance values of from 1 to 32 henrys to be made available.

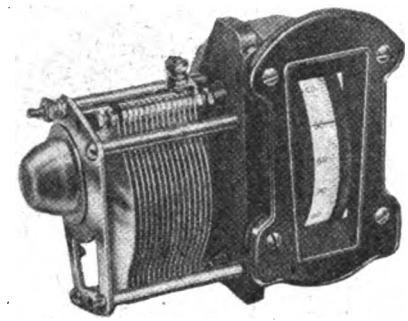


R.I. Dual Astatic H.F. choke with cover removed.

In spite of the technical difficulties concomittant with true ganging of H.F. circuits, many component manufacturers are giving attention to the design of condenser units for this purpose. A noteworthy example of the steps taken to compensate for discrepancies in the incidental capacities across the various circuits is exhibited in the design of the Utility "Mite" double condenser unit. Here the rotors are linked and driven by a drum control. To enable the small differences in capacities to be corrected, provision is made for rocking the two sets of fixed vanes. By an ingenious mechanical arrangement, the stators are moved differentially.

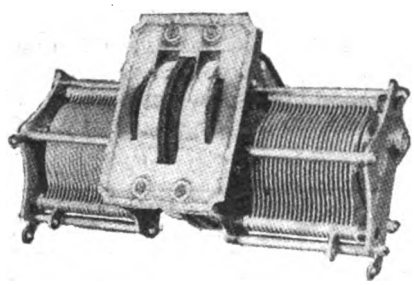


Pye sectional wound heavy duty L.F. choke Model No. 687.



Polar condenser in which the slow motion controls would be adjacent when a dual assembly is used.

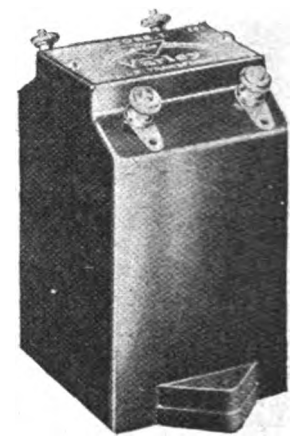
When additional capacity is introduced into one circuit, the value of the capacity across the other is reduced. This must not be confused with a "trimming" device, since a given angular displacement of the stators does not represent a constant capacity change between minimum and maximum values of the condensers. It should be regarded as a compensating device which will require adjustment at various positions of the rotors.



Burton Twin Drum condenser giving coarse tuning on the centre adjacent controls and fine tuning on the outer controls.

The semi-ganging of circuits, as obtained by the adoption of drum controls—arranged so that the operating edges are adjacent and placed conveniently for combined movement by one finger—is being widely adopted by set manufacturers. Consequently, we find an extensive range of condenser units exhibiting this feature. In the majority of cases both slow- and direct-drive drums are provided. Coarse adjustment is obtained by mounting the two direct-drive discs side by side, and fine tuning is then carried out independently by means of the slow-motion drives, which are mounted generally on the outside. There are, however, some exceptions, notably in the case of the Polar assembly, where the slow-motion drives are adjacent and the coarse adjustments on the outside.

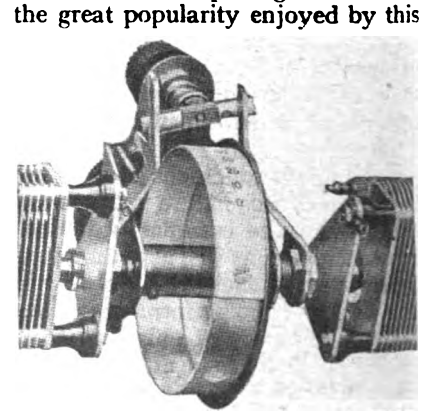
This method of tuning calls for a right- and a left-hand style of condenser. Manufacturing difficulties may occasionally arise. There is at least one example of a condenser designed for optional right- or left-hand drive. This is the J.B. "Universal Log" model, which is made in four sizes, ranging from 0.00015 mfd. to 0.0005 mfd.- An adjustable steel



Special high permeability material is used for the core in this Varley "Ni-core" L.F. transformer.

centre spindle is fitted, and a single-hole fixing bush is provided at both ends.

While one does not find many special components designed particularly for use in portable sets, there are nevertheless some which can be included in this class. This fact is rather surprising, in view of the great popularity enjoyed by this



Provision is made for moving the fixed vanes by differential action in the Utility "Mite" double condenser.

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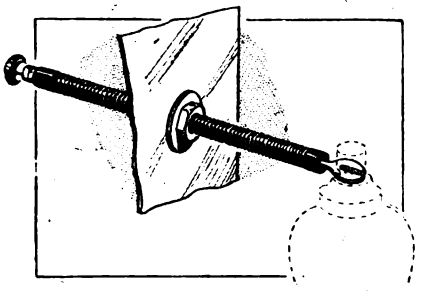
The Trend of Design.—
type of receiver during the past twelve months and the present indications that it is likely to continue. The previously mentioned Utility "Mite" and the new J.B. "Tiny" condensers are, however, two excellent examples of real endeavour to produce a suitable component of very small physical size. The "Tiny" is fitted with a slow-motion drive, and, complete with knob, pointer and scale, costs 10s. for a 0.0005 mfd. size and 9s. 6d. for the 0.0003 mfd. model. Other sizes are available. Formo and Burton are two others firms who make condensers smaller than the familiar pattern, and these could be included under the same heading.

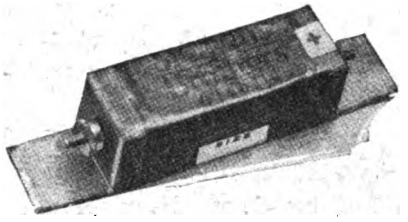
In some cases manufacturing costs have been the prime mover in the design of a component. For example, the wider use of mu-metal, and similar material, for the core in L.F. transformers has enabled the manufacturer to produce a component



Bulgin "safety connector" for use with screen grid valves.

cheaper than one of equal quality using common transformer steel. In many cases a superior component has been developed. In view of the special properties possessed by these substitutes for steel, some care is required in their use, and this has occasioned a new method of linking together L.F. amplifying stages. Many of these transformers will not stand for more than one or two milliamps of current through their primaries, so that arrangements must be made to deflect the steady anode current through a parallel circuit and pass the A.C. component only through the windings. A discussion of these couplings does not come within the scope of this section, being concerned as we are only with components. Nevertheless, mention must be made of this as it is a vital factor in the employment of such components as the R.I. "Hypermu" L.F. transformer and the Varley "Ni-core" range.

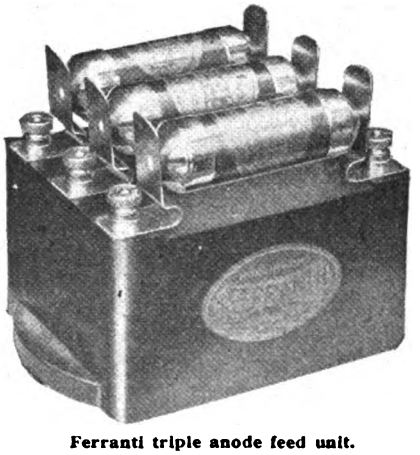
The Varley "Ni-core" L.F.



For biasing a S.G. valve the Siemens 0.9 volt cell is ideal.

transformers are likewise restricted in the value of steady current that may be passed through their primary windings. The "Ni-core I" will carry 2.5 mA. and "Ni-core II" 2 mA. only. The former costs £1 and the latter 15s. Both have a ratio of 4 : 1.

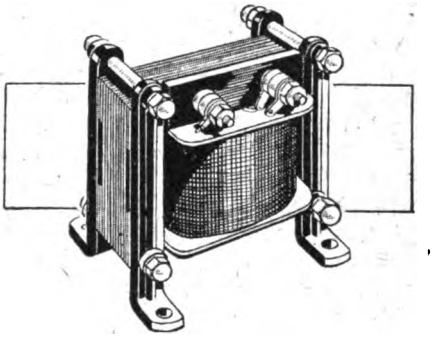
As an illustration that the development in one direction engenders improvements elsewhere can be cited the case of the screen grid valve. Its wider use since first pointing the way towards higher H.F. stage gain in a comparatively simple manner has resulted in component manufacturers producing additional parts especially for use with this device. Bulgin has evolved an interesting safety connector for the anode of the valve. This takes the form of a flexible wire encased in an armoured sheath to which is attached a fixing bush for anchoring to vertical screens or the side of a screening box. One end of the lead terminates in a spade connector for fixing under the top terminal on the valve, while the other end is finished off by a small terminal for attaching the lead carrying the H.T. As the connector is permanently fixed to a rigid part of the set, no damage can be done by removing the valve without first totally disconnecting the H.T. supply.



Ferranti triple anode feed unit.

While on the subject of screen grid valves, mention must be made of the special grid bias cell developed by Messrs. Siemens Bros. and Co., Ltd., and now shown for the first time. It has a voltage of 0.9, and will give to the operating grid of a screen grid valve just the right amount of bias for the best working conditions. Hitherto the lowest voltage cell available was 1½ volts, and this over-biased the modern S.G. valve.

A new component, illustrating the more universal use of special devices to combat motor-boating in mains-driven sets, is a product of Ferranti.



Wearite constant inductance L.F. choke.

This is one of a range of anode feed resistance units comprising three resistance holders and three by-pass condensers. Its normal use is as a triple device where space is limited, but it has a further application, namely, that of a fixed potentiometer to supply the screen potential for a S.G. valve. Used in this manner, it assures a constant voltage on the screen of the valve in spite of slight fluctuations in the current.

Since the set manufacturer is endeavouring to make his products more like pieces of furniture than at any previous period in the short history of broadcasting, it behoves the component maker to add his mite towards this end. We thus find such firms as Ormond, famed for their dials, now showing these in a variety of colour schemes.

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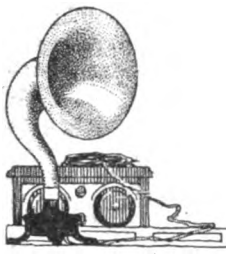

AIDS TO SELECTIVITY

Some Notes on the Use, Construction and Performance of Rejectors in a Simple Aerial Circuit.

By H. B. DENT.

IT is anticipated that the majority of broadcast listeners living in the north of London will be affected in one form or another by the change over from the Oxford Street site to Brookmans Park for the London Regional transmitter. Possibly by the time these notes appear in print all those so concerned will have had an opportunity to test the selectivity of their sets under the new conditions. Owners of receivers incorporating H.F. amplifiers with sharply tuned circuits should find no difficulty in listening to alternative programmes, but there must be many possessing less ambitious sets who will find that with the new station in operation the alternative programmes are now no longer receivable, or heard only during intervals in the transmission.

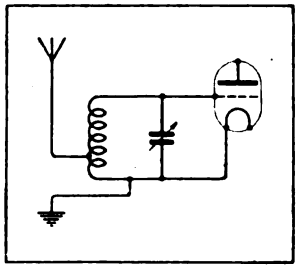

Fig. 1.—Typical aerial-grid circuit used in modern sets.

For the present, one programme is to be transmitted from the new station, and since the alternative is either Daventry 5GB, or some of the more powerful Continental stations, the problem resolves itself into a consideration of the ways and means of eliminating the signals from the powerful local transmitter and rendering reception of considerably weaker signals possible. When the full programme of the new London Regional station is in force, it should be far easier to separate the two transmissions, because less amplification will be required. It is apparent that a modification or addition to the set will be necessary, but until it has been possible to study at first hand the effect on one's particular receiver, it is somewhat difficult to decide on the nature and extent of these modifications.

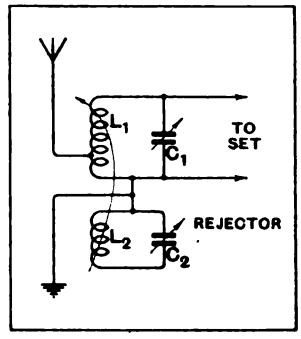

Fig. 2.—Circuit of a simple "absorption" type rejector.

In the meantime some good work can be done with a rejector circuit, and this is perhaps the most satisfactory method of making provision, temporarily at least, for alternative programmes. Of course, this is really a palliative, but oft-times recourse has to be made to palliatives until a remedy can be prepared. It is the object of these notes to discuss the best method of applying a rejector which will meet the immediate needs until such time as a more permanent cure can be devised. Perhaps the most popular type of aerial circuit used to-day is that shown in Fig. 1. This, then, will be taken as the basis for our discussion. It matters little what function the first valve performs, whether H.F. amplifier or detector, although if a high-frequency amplifying stage precedes the detector it will, by virtue of the higher selectivity, simplify the filtering-out of the unwanted signals.

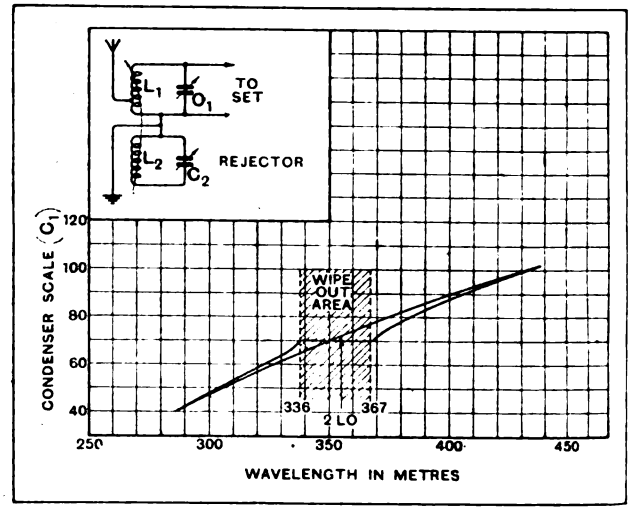

Fig. 3.—Curves showing the effect on the tuning of a circuit when a rejector is coupled to it. The uninterrupted curve is the normal calibration.

Absorption Rejectors.

For the purpose of this discussion rejectors will be divided into two classes—the "absorption" type and the "series" type. In effect they are identical, and it is only in their application that they differ. The "absorption" type, of which a typical example is shown in Fig. 2, consists of a tuned circuit L_2 C_2, arranged so that the coil L_2 is inductively coupled to the aerial-grid coil L_1. It is desirable to use a low-resistance coil for the rejector, a small inductance in conjunction with a large capacity giving the best results. This must be judged by the effect the presence

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Aids to Selectivity.—

of the rejector has on the receiving circuit. An appreciable resistance, that is, H.F. resistance, in the rejector circuit will necessitate a very tight coupling between the two circuits, and this will absorb energy from the aerial-grid circuit over a wider band of wavelengths than is really desirable in the interests of selectivity.

The ideal rejector is one that absorbs energy from the receiving circuit over a band of frequencies equivalent to that occupied by the modulation of the transmission it is desired to reject. This is not possible to achieve in a simple arrangement, but with the exercise of a little care in the design the "wipe-out" area can be kept reasonably small.

The curves in Fig 3 show the effect on the tuning of a circuit similar to that depicted in Fig. 2. The

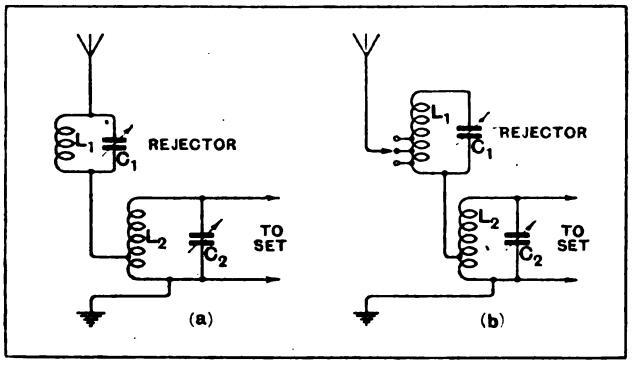

Fig. 4.—Circuits of the two "series" type rejectors. That shown in (b) is generally more satisfactory than the arrangement (a).

coupling between the aerial circuit and the rejector was such as practically to eliminate signals from 2LO (Oxford Street site) at a distance of 1¾ mile. The "wipe out" area in this case represents a matter of 31 metres; that is to say, nothing can be received between the upper and the lower limits, or between 336 and 367 metres. A looser coupling has the effect of reducing the width of the "wipe out" area, but this is offset by the breaking through of signals from the unwanted station, so that little is gained by adopting this course. In this particular case the coil L_2 was wound with Litz wire, 40 turns being used on a 3in. diameter former. The condenser C_2 had a capacity of 0.0005 mfd.

Series Rejectors.

The "absorption" type of rejector necessitates a slight modification to the set, since space must be found inside the cabinet for the rejector coil and its condenser. However, there are alternative arrangements which can be applied external to the set and give very much the same results. These will be classified under the heading of "series" type rejectors because they can be connected in series with the aerial. Typical examples are shown in Fig. 4 (*a*) and (*b*). The arrangement in Fig. 4 (*a*) will be passed over with but a mention, and is only included to complete the series. It is effective certainly, but the coupling is far too tight for practical use, as the "wipe out" area extends over an unnecessarily large part of the waveband covered by the receiving circuit.

The circuit given in Fig. 4 (*b*) will be found satisfactory in most cases and readily lends itself to use with most receivers. The remarks passed regarding the type and size of coil apply with equal force to this case, although owing to the aerial-earth damping, possibly solid wire of fairly stout gauge could be used in place of the Litz. A practical test showed that a coil wound with 40 turns of No. 22 S.W.G. D.C.C. wire gave good results. The tappings for the aerial connection were made at 10th, 15th, and 20th turns from that end of the coil connected to the aerial terminal on the set. With the aerial connected across 15 turns of the coil, little could be heard of the local station when the aerial condenser was detuned 10 divisions, on a dial marked 0-180, either side of resonance. The "wipe out" area was of the same order as that recorded with the direct absorption type, shown in Fig. 2.

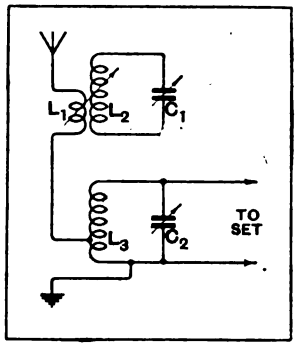

Fig. 5.—Modification of Fig. 4 (b) which justifies the use of a low resistance rejector circuit L_3C_1.

A variation of this arrangement is given in Fig. 5. In this case a small coil L_1 is coupled to the main rejector coil L_2. Tests showed that there was some justification for using Litz, although quite a good performance was recorded when solid wire of the gauge mentioned above was employed. The aerial coil L_1 consisted of 15 turns of fine gauge wire wound over one end of L_2. Eight distance pieces were used and the turns spaced to occupy ½in. in length.

This rejector was particularly good and measurements showed that the "wipe out" area was of the

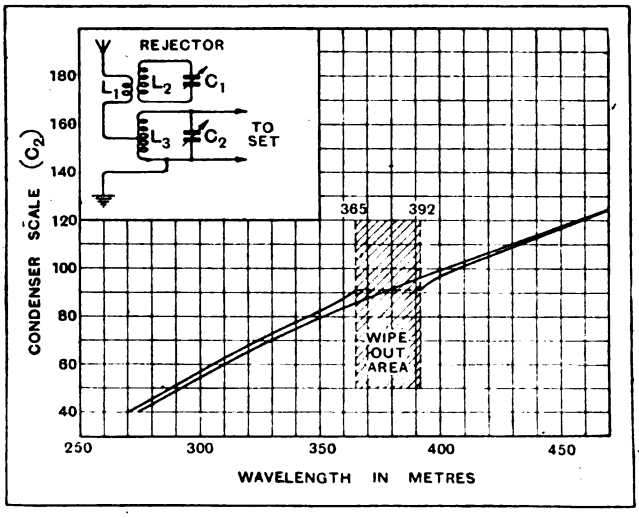

Fig. 6.—With the "series" type rejector a tight coupling tends to shift the "wipe-out" area to one side of the actual wavelength of the rejected signal (in this case that of 2LO).

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Aids to Selectivity.—

same order as that given in Fig. 3. Whereas previously the local station's programme was audible over the whole range of the tuning condensers, with the rejector in position it was possible to receive signals as near as ten divisions off tune either side of that corresponding to the tuning position for the local station.

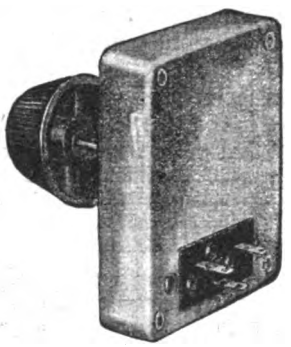
The "Wipe Out" Area.

During the course of these observations on the performance of the various arrangements mentioned here, some rather peculiar effects were recorded. For example, with certain types of "series" rejectors it was noticed that the "wipe out" area was displaced and actually occupied a position some metres above the normal tuning position of 2LO. This is shown in the curve given in Fig. 6. With this particular arrangement signals from the London station were fairly completely rejected, yet the blank area, as subsequently found by taking a calibration curve of the circuit with and without the rejector in position, showed that this appeared to be effective between 365 metres and 392 metres. This was finally checked with a heterodyne wavemeter and no signals could be tuned in between these two limits, although sundry Morse C.W. stations were heard on either side of the "wipe out" area.

It is not the purpose of these notes to explain the cause and effect, the object being to record observations with the various arrangements depicted here. Far more detailed investigation will be necessary before many of the rather unusual effects noticed can be satisfactorily explained; for the moment, the practical application of the rejector circuit is the first aspect to receive attention.

SOME INTERESTING AMERICAN APPARATUS.

THE Rothermel Corporation's programme for the coming winter season includes the marketing in this country of a number of new components not previously available on this side of the Atlantic. In addition, many of their familiar lines have been remodelled by the manufacturers. Some new designs of Magnavox moving-coil loud speakers are now available. These are catalogued as "X-core" type and are supplied with 7½in. and 10½in. diaphragms. The A.C. models include mains and input, transformers, and dry metal rectifier, the prices ranging from £8 5s. to £11. A new component is the Mershon "Amrad" electrolytic condenser of high capacity and tested to withstand 400 volts D.C.; single and double types are available. The leakage current is given as 1½ to 2 mA per 10 mfds. capacity.



Electrad super-Tonatrol. A power potentiometer rated to dissipate 5 watts.

Some new "Royal" metal-cased fixed condensers, ranging from 0.1 to 4 mfds., are now listed. These are tested to withstand 1,650 volts, and prices range from 2s. to 7s., according to size.

New Volume Control.

Of particular interest is the new "Electrad" super Tonatrol. This is made as a variable high resistance and a potentiometer, and is claimed to dissipate 5 watts at any position of the contact. The resistance element consists of a special graphite preparation fused at high temperature to an enamelled steel plate. A floating silver contact is employed, which adapts itself to any slight inequality of the surface and ensures smooth action. It is protected by a metal case with bakelite insulation and fitted with stout bronze contact springs. Prices are as follows: Resistances of 10,000 ohms and 50,000 ohms cost 12s 6d., and potentiometers of 10,000 and 25,000 ohms are offered at the same price. A special gramophone pick-up "fade-out" device for use with two turntables is priced at 15s.

Electric Gramophone Motor.

Constructors of electrically driven gramophone equipment will be interested in the Bodine A.C. induction motor. This is a high quality piece of apparatus, and complete with turntable and necessary controls costs £10 10s. It is made for 110 and 220 volts 50 cycles A.C. supply mains.

Two types of American condensers. That in the cylindrical container is an "Amrad" 90 mfds. electrolytic condenser; the other a "Royal" 2 mfds. 1650 volts test component.

New Magnavox "X-Core" moving coil loud speaker.

A range of power amplifiers for public address, and similar uses, and designed for A.C. mains operation, is another new feature. These are used extensively in the U.S.A. and are products of the Samson Electric Co.

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BOOKS RECEIVED.

Radiotechnik (Part VI) Die Elektrischen Wellen, by Dr. F. Kiebitz, Professor of the Berlin University.—A short text-book on the propagation and theory of wireless waves. Pp. 125, with 28 diagrams. Published by Walter de Gruyter and Co., Berlin and Leipzig. Price Rm.1.50.

Short Stories in Science, by J. G. Crowther.—A popular treatise on natural science, including the Nature of the Universe, Refrigeration, Volcanoes, Lightning, The Atom, The Raman Effect, and many other subjects. Pp. 213. Published by George Routledge and Sons, Ltd., London. Price 5s. net.

Radio Telegraphy and Telephony.—A complete text-book for students of wireless communication, by Rudolph L. Duncan and Charles E. Drew. Pp. 950, with 468 illustrations and diagrams. Published by John Wiley and Sons, Inc., New York, and Chapman and Hall, Ltd., London. Price 37s. 6d. net.

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Broadcast Brevities

By Our Special Correspondent.

A New 5GB.—B.B.C. Under Fire.—"Broadcasting House."

The Rebuilding of 5GB.

The B.B.C. has wisely decided to rebuild 5GB (Daventry) before it takes its permanent place in the regional scheme. "Daventry Junior" has always been a makeshift station and, judging from what I saw on my first visit to Daventry, the marvel is that the breakdowns have been so few. Contrasted with the "spick-and-spanness" of Brookman's Park, 5GB is a "hookup" in the best English sense of the word.

When rebuilt, the station will be a replica of the Brookman's Park station, but with only one transmitter. In this respect it will resemble the projected regional station for Ulster. The increase in power from 25 kW to 30 kW will, it is hoped, help to cut out that very noticeable interference from Langenberg.

°°°°

B.B.C. Disappoints at Olympia.

"And when the sun rose, where were they?" This question, in various forms, seems to have been on the lips of most visitors to Olympia. Where are the B.B.C.?

On the first day of the Show the much-heralded diorama was out of action; but, ignoring this lapse, the best friend of the Corporation could hardly describe the B.B.C.'s rôle at Olympia as a spectacular one.

Echoing John Henry, "It's all wrong." The B.B.C., as providers of the celestial food on which all those beautiful receivers thrive, should have taken Olympia by storm, demanding a place in the sun, and not merely an odd corner or two.

°°°°

Those Programmes.

If we imagine a succession of long waves of rather small amplitude we obtain a graphical delineation of the quality of the B.B.C. programmes. The waves of popular opinion are usually a little out of phase, so that when the B.B.C. programmes are emerging from one of the troughs, the public are just beginning to realise how bad the programmes have been. We seem to have reached such a stage at the present moment.

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Dance Titles Again?

Some of the criticism is being levelled at the dance programmes broadcast from outside sources. Personally, I know nothing more boring than to listen to a succession of unannounced items given by a disheartened cabaret band which is bound to secrecy regarding dance titles and which dare not burst into song lest the dread secret should be revealed. I should not be surprised, however, if the B.B.C. were shortly to remove the ban on dance titles, despite the risk of "song-plugging." Special care would be taken, of course, to prevent as far as possible any subsidising of artists by the dance publishers

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Morbidity at the Microphone.

The subject-matter of a singular broadcast from 2LO on October 10 is the beginning of the end of a man's life. The action occurs during the infinitely short space of time taken by sudden death to establish itself. The title of the drama is "The First Second," by Peter Godfrey, and it will be produced by Lance Sieveking.

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Below the Scenes at Portland Place.

Although "Broadcasting House" will not be ready for occupation until June, 1931, some of the toughest work has already been accomplished. To appreciate the immensity of the work the best plan is to take a seat in one of the crane buckets—a privilege I enjoyed last week—and allow yourself to be gently lowered 40ft. below the surface of the road, until the bucket grounds on the reinforced concrete foundations. You are then on the lowest of the three basement floors, above which the building will tower another eight storys.

Col. Val Myer, the architect, drew my attention to a bubbling spring which will have to be diverted and "tanked" before the massive retaining walls around the site can be completed.

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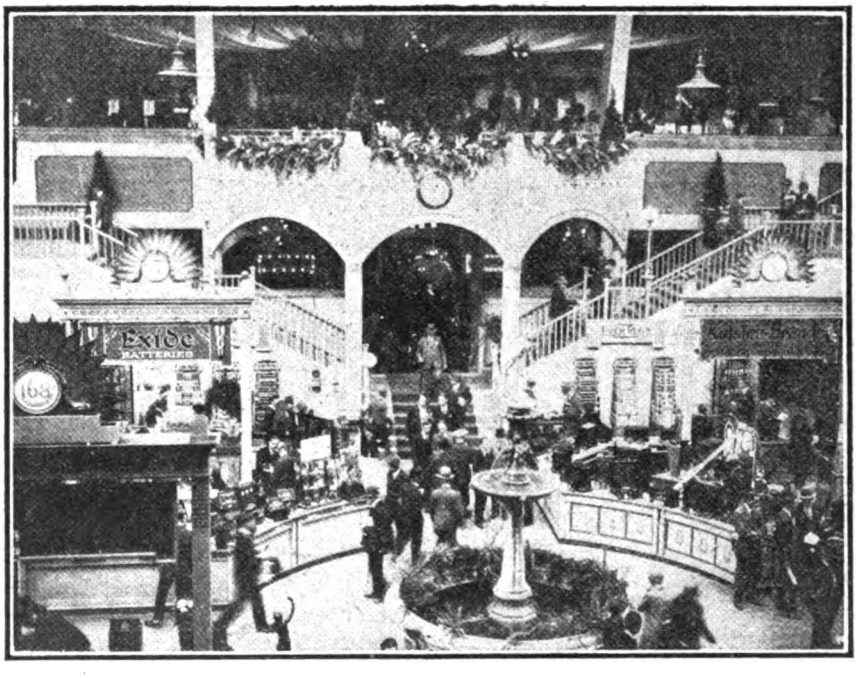
Sound-proof Walls.

A really unique feature of "Broadcasting House" will be the absence of a central well which all normal buildings of its size require for lighting and ventilation. The centre will be taken up by a tower with sound-proof walls of solid brick 3ft. thick, and this will house the main studios and a theatre capable of accommodating 1,000 people. The studios will be two storys in height and will be acoustically insulated from each other by single floors accommodating offices.



THE FUN OF THE FAIR. An interesting photograph taken on the opening day of the National Radio Exhibition. There have been record attendances.

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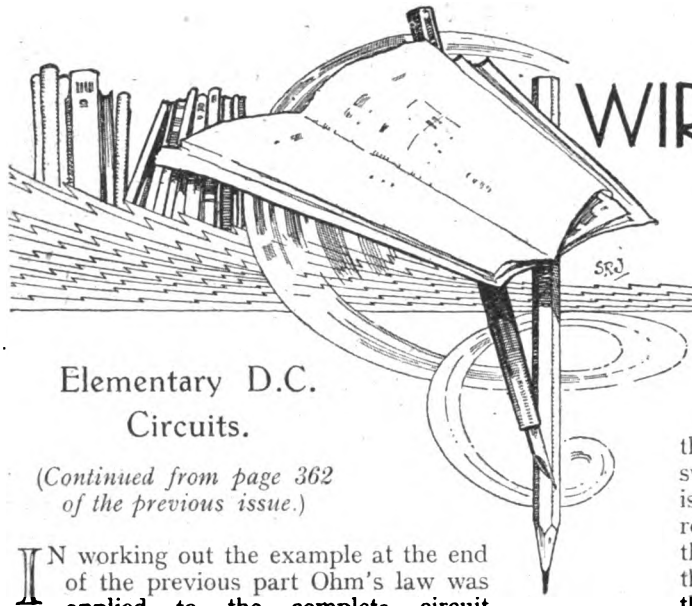

WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

Elementary D.C. Circuits.

(*Continued from page 362 of the previous issue.*)

IN working out the example at the end of the previous part Ohm's law was applied to the complete circuit consisting of a 6-volt battery and an external resistance of 3 ohms connected across its terminals. The current was found to be 1.875 amps. and not 2 amps. as might at first have been expected, the reason being that the resistance of the battery itself makes its influence felt. From this it is clear that the electromotive force actually applied to the external 3-ohm resistance must be less than 6 volts. This is the truth, and its value can be very easily found by applying Ohm's law to the external resistance only. Let V denote this reduced value of the E.M.F. which is effective in driving the current through the resistance R. Then by Ohm's law

$$V = I.R \text{ volts.}$$
$$= 1.875 \times 3 = 5.625 \text{ volts.}$$

So that although we have a 6-volt battery we are left with only 5.625 volts at the terminals when a 3-ohm resistance is connected across it. The remaining 0.375 volt has been absorbed in driving the current (1.875 amp.) through the internal resistance (0.2 ohm) of the battery. This can be verified by applying Ohm's law to the resistance of the battery, viz.: The E.M.F. required to drive a current of 1.875 amps. through a resistance of 0.2 ohm is $1.875 \times 0.2 = 0.375$ volt. as before. This loss of pressure due to the internal resistance of the battery is commonly referred to as the *voltage drop* in the battery. It is always present to some extent and militates against efficiency, causing waste of energy in the battery, and, in the case of high-tension batteries in wireless circuits, it very often results in instability and violent oscillation or howling.

Electromotive Force and Potential Difference.

Now we must get back to symbols for a little while and introduce one or two new and important terms which recur very often in discussing the operation of any receiving circuit. The same circuit as that of Fig. 1 of the previous instalment is reproduced in Fig. 1, with the addition of an ammeter A, a voltmeter V and a switch S. It will be supposed that the ammeter, which is connected in the main circuit, has a negligibly small resistance so that it does not reduce the current, and that the voltmeter which is connected directly across the battery terminals has such a high resistance that the current taken by it is negligibly small.

When the switch S is closed and a current of 1 ampere is flowing round the circuit the voltmeter will give a reading V which, as we have seen, is less than the electromotive force of the battery; but if S is opened the voltmeter reading will rise until it equals the actual E.M.F. of the battery, because the current has now ceased and therefore no fraction of the E.M.F. is being absorbed in overcoming the battery resistance. From all this it might at first appear that the E.M.F. of the battery is not a constant thing, but varies according to the current. But this is not the case—the electromotive force of a battery is a constant quantity (except when the battery is running down), depending only on the chemicals and elements from which it is made and, to a certain very small extent, on the temperature. It is only the resulting electrical pressure existing between the terminals which varies, and it is here that we must introduce the term "potential difference" (P.D.).

Voltage, Pressure and Potential.

The electrical pressure between any two points in a circuit, as measured with a voltmeter, is called the potential difference between those two points. When measured in volts it is sometimes referred to as "the voltage." For the word "potential" we can always substitute the word "pressure," meaning, of course, electrical pressure.

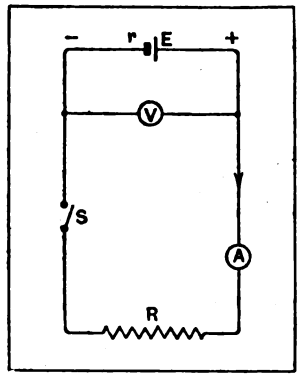

Fig. 1. — Simple circuit showing loss of voltage in the battery due to internal resistance.

It is very important to get a clear conception as to the difference in meaning between electromotive force and potential difference. Although each is measured in volts they really have different meanings, which must not be

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Wireless Theory Simplified.—

confused. Electromotive force is the driving force set up in the cells by electro-chemical action (or in a dynamo by electromagnetic action), and is a constant in the case of a battery or cell. Potential difference, on the other hand, is the resulting pressure built up when the current is being forced against the various opposing resistances in the circuit. If the circuit is open the resistance is infinitely great and the potential difference between the terminals of the battery builds up to a value exactly equal to the E.M.F. To assist in grasping this idea of opposed forces, consider a steamer standing stationary on a calm day in still water and that suddenly the engines are started and propellers rotated so as to give a steady forward thrust of, say, 50 tons. The steamer will immediately begin to move and its speed will get faster and faster; but it will not go on accelerating indefinitely—there will come a time when the resistance of the water and air will prevent further gain of speed. The speed will build up to just such a value that the resisting forces exactly oppose the driving force.

This is precisely what happens in our battery circuit: When the switch is closed the current builds up until it has reached just such a value that the resisting forces exactly counterbalance the driving (electromotive) force. The E.M.F. is the driving force, and the potential difference is the resulting back pressure due, in this case, to the motion of the electrons against the resistance in the external circuit.

Potential.

There is yet another aspect of the word "potential" which must be considered. In our wireless work we often encounter the phrase "plate potential" or "anode potential." For instance, when it is stated that a valve is meant to operate with an anode potential of 150 volts most readers will know that this indicates that the valve should be operated with a potential difference of 150 volts between the anode and *the negative end of the filament.* But why the negative end of the filament? The reason is that the negative end of a valve filament is usually "earthed" in a receiving set, so that the potential of the anode is really the potential difference in volts between the anode and earth. In general, then, it must be understood that the *potential at any point in a circuit is the potential difference between that point and "earth,"* the potential of the earth being considered as zero.

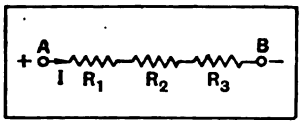

Fig. 2.—Resistances in series. Total resistance $= R_1 + R_2 + R_3$.

The energy possessed by anything is the capacity it has for doing work of some kind. For instance, a wound clock spring has the capacity for driving a clock for a definite length of time. In the same way a battery or an accumulator possesses energy which is stored in a chemical form, and, when a current is drawn from the battery, work of some kind is done, the nature of this work depending on the type of apparatus connected to the battery.

In the simple battery and resistance circuit which we have been considering the work done is represented by the driving of the electrons through the resistance of the circuit, this causing the resistance wire to become heated. Actually the energy which is coming from the battery is not being destroyed, but simply converted into heat—another form of energy. It is a well-known law that no energy can ever be created or destroyed, but merely converted from one form into another. By suitable means we are able to convert the stored energy in the battery into motion, light, sound, heat, etc.

The temperature to which our resistance wire will be raised will depend on the rate at which energy is being put into it, that is, on the rate at which work is done, and it is this rate of expenditure of energy with which we are most concerned. It represents the *power* being expended in the electric circuit.

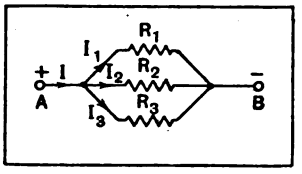

Fig. 3.—Resistances in parallel. The current divides in inverse proportion to the respective resistances.

In ordinary mechanical things the rate of doing work, i.e., the power, is given by the product of the driving force and the rate of movement of the driven body, and similarly in the electric circuit the power is equal to the product of the electromotive force (electric driving force) and the current (rate of movement of electrons). The unit in which the electric power is measured is the *watt,* where one watt is the power represented by a current of one ampere flowing under a pressure of one volt. Thus in a circuit where the pressure is E volts and the current I amperes the power being expended is given by

$$P = E \times I \text{ watts.}$$

If the potential difference between the ends of a circuit is E volts and the current in it is I amperes the power being put into it is $E \times I$ watts no matter into what form it is being converted. But when the circuit consists of a simple resistance of R ohms the whole of the power is utilised in producing heat. From Ohm's law we know that $E = I \times R$, and, substituting this in the above expression for the power, we get

$$P = I^2R \text{ watts.}$$

Heat Losses in Relation to Current and Resistance.

This is a very useful expression indeed, and enables us to calculate the power, in watts, being lost as heat in any circuit where we know the resistance and the current. It should be noted that the power being converted into heat is proportional to the *square* of the current, so that by doubling the current in a given circuit we expend four times the power. This is obviously the case, because in order to double the current the voltage must be doubled also.

The conclusion is that whenever a current flows through a circuit heat is produced, and, conversely, whenever heat is produced by an electric current resistance is present in the circuit. The latter fact will prove of great assistance to us when considering alternating current circuits at a later date.

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Wireless Theory Simplified.—

Series and Parallel Circuits.

A number of resistances are said to be connected *in series* if they are so arranged that the same current passes through each in turn. In Fig. 2 we have three resistances, R_1, R_2 and R_3, connected in series, and it can be shown very easily that the total resistance R of this circuit is equal to the sum of the individual resistances, namely:—

$$R = R_1 + R_2 + R_3.$$

It is very important to remember that at any instant *the current is the same at every point in a series circuit.* Series connection is sometimes referred to as cascade connection.

Resistances are said to be connected in parallel when arranged as shown in Fig. 3. Let E be the potential difference applied between the ends A and B of the circuit. Then the individual currents through the respective resistances R_1, R_2 and R_3 will be E/R_1, E/R_2 and E/R_3, and the total current will thus be $I = E(1/R_1 + 1/R_2 + 1/R_3)$ amps.; therefore $I/E = 1/R_1 + 1/R_2 + 1/R_3$. But by Ohm's law E/I is the combined resistance R of the circuit, and thus I/E is the reciprocal $1/R$. For the parallel circuit, then, we have

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3},$$

or, expressed in words—for resistances in parallel the reciprocal of the resultant resistance is equal to the sum of the reciprocals of the individual resistances.

Numerical Example.

Suppose that in a receiving set we are using three valves each rated for a filament voltage of 5.5 volts, but requiring currents of 0.1, 0.25 and 0.3 amp. respectively. Dividing each of these currents into the voltage we get for the resistances of the valve filaments 55 ohms, 22 ohms and 18.33 ohms respectively. The reciprocal of the combined resistance is thus

$$\frac{1}{R} = \frac{1}{55} + \frac{1}{22} + \frac{1}{18.33} = 0.1184,$$

and the resistance $R = \frac{1}{0.1184} = 8.47$ ohms.

This is the equivalent resistance of all three valves in parallel, and if our working is correct the total current will be obtained by dividing the voltage by this figure:

$$\text{Total current } I = \frac{5.5}{8.47} = 0.65 \text{ amp.}$$

Also $I = 0.1 + 0.25 + 0.3 = 0.65$ amp., which checks both the method and calculation as being correct.

In the foregoing pages we have discussed the fundamental principles of the very simplest of electric circuits chiefly for the benefit of those readers who have not studied these principles before in any detail. The discussion is necessarily very brief, but it is hoped that sufficient has been said to give the reader a good idea of what takes place in such circuits. Without these fundamental ideas it would be impossible to follow intelligently the succeeding discussions on alternating current circuits and the application of the principles to receiving circuits.

BY-PASS CONDENSERS FOR HIGH FREQUENCY.

Taking H.F. Resistance Into Account.

MOST modern receivers positively bristle with decoupling resistances and condensers that are intended to divert into harmless paths the various alternating currents that might cause trouble if allowed to stray about. When it is currents of low frequency that we are trying to by-pass through earthing condensers to the filament of the valve it is only necessary to choose condensers of large capacity, the type having paper dielectric serving perfectly well.

The selection of a condenser for a high-frequency circuit, however, needs rather greater care. When dealing with high-frequency currents it is no longer quite safe to assume that of two condensers, one having ten times the capacity of the other, the larger will offer one-tenth of the impedance to their flow. There now enters into the question the resistance offered by the condenser plates themselves to the passage of high-frequency currents.

Let us imagine that a foil condenser is constructed from a long, narrow strip of waxed paper, with a very thin metal foil on each side, and that connection is made to the two foils at the same end. If a high-frequency voltage is applied to the terminals the full voltage will be operative across the waxed paper dielectric in their immediate neighbourhood, but owing to the very appreciable resistance of the foils the voltage-drop along them will be great enough to render the far end of the strip practically inoperative as a condenser. The far ends of the foil are, in fact, protected from the applied voltage by a very thorough and elaborate decoupling scheme of series resistance and parallel capacity. A two-microfarad condenser constructed on the lines suggested, in which the shortcomings of many paper condensers are illustrated in exaggerated form, might well offer no less impedance to currents of very high frequency than a condenser of nominal capacity one-tenth or one-hundredth of its value, but with foils of negligible resistance. In the usual mica condenser, for example, there are usually two sets of small paralleled foils, so arranged that every individual foil in each set makes direct connection with the appropriate terminal on the case. With such a mode of construction the effective resistance of the foils will be negligible.

Several manufacturers of paper condensers have arranged to make connection to each foil at a very large number of places, so that with their products the full rated capacity will be effective even at very high frequencies. The choice of one of these, or of a mica condenser, is a measure of precaution that it would be wise to take when choosing condensers to by-pass high-frequency currents in a modern high-gain amplifier. —A. L. M. S.

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THE PENTODE AS AN ANODE RECTIFIER

Incorporating the Detector in a Receiver.

By A. L. M. SOWERBY, M.Sc.

(*Concluded from page 286 of the September 18th issue.*)

BEFORE building a receiver in which the pentode occupies the position of detector, it is desirable to know a little more of its behaviour than can be brought to light by the simple measurements that were described in the first part of this article. We have seen that the characteristics of the pentodes at present available are such that resistance-coupling to the next valve is desirable, and that by suitable choice of auxiliary and signal-grid voltages and of anode resistance we can obtain more sensitive detection than the three-electrode valve can provide. We have still to consider the effect on the efficiency of rectification of shunt capacities in both plate and auxiliary grid circuits, and to investigate the damping effect that the detector produces on the tuned circuit from which, in a normal receiver, it receives the voltage that it is called upon to rectify. Further, it will be of interest to make some sort of rough estimate of the rectified low-frequency voltage that the pentode will hand on to the next valve for further amplification, and of the most satisfactory high-frequency input that the valve requires for efficient rectification.

By-pass Condensers.

In order to determine whether the presence or absence of shunt capacities in anode or auxiliary-grid circuits affect in any way the process of rectification proper[1], a constant high-frequency voltage was applied to the valve and the change in plate current due to the rectification of this voltage was read. In order to ensure that the input to the valve really did remain constant while alterations were being made to its plate circuit, the arrangement shown in Fig. 7 was adopted. The resistance r had a value of some 150 ohms, which was deemed low enough to be negligibly small in comparison with any parallel resistance due to the valve, while it was found to be high enough to flatten the tuning of the circuit sufficiently to make certain that capacity changes due to the condensers connected would not, by upsetting the tuning, introduce unintentional alterations of the input voltage.

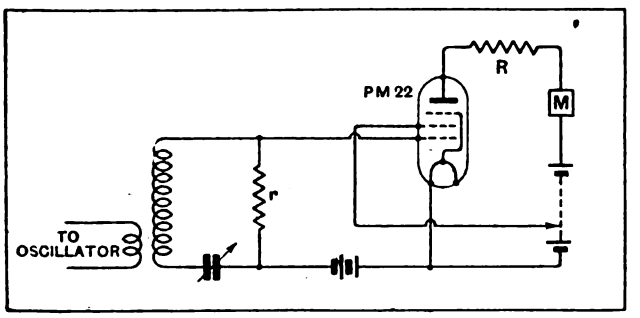

Fig. 7.—Using the pentode detector as in the above circuit, condensers were connected across plate and auxiliary-grid circuits. No change in rectified current was observed.

With these precautions condensers of various values, ranging from 0.0001 mfd. to 0.01 mfd. were connected in turn between plate and filament and between auxiliary grid and filament of the PM22. The deflection in the meter M obtained when no external capacity was connected across either of these paths remained unchanged whatever the value of the condenser used. From the point of view of the rectification of a carrier wave only, any value of external capacity from zero upwards may be used without in any way affecting the efficiency of the rectifier.

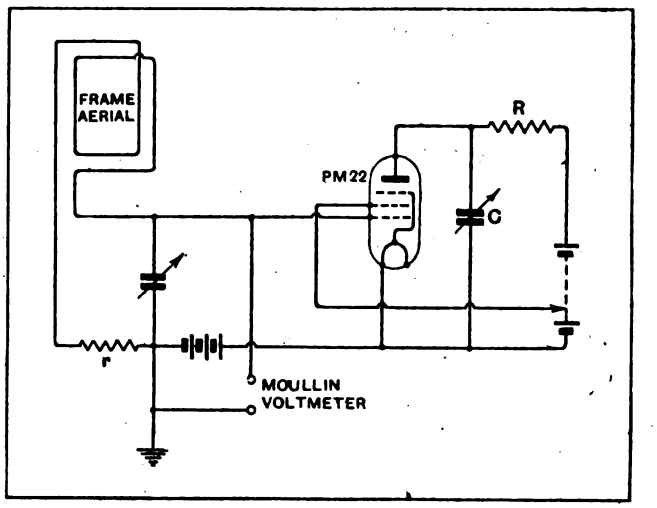

Fig. 8.—With the aid of a calibrated condenser C and a Moullin voltmeter, this circuit enables the damping introduced into the tuned circuit by the detector to be measured. The magnitude of the damping is compared with that produced by the resistance r. See Figs. 9 and 10 for the results obtained.

It has, however, been shown that the presence of a shunting condenser across the anode circuit of the valve is an essential to the proper reception of a modulated wave.[2] Furthermore, it is known[3] that this condenser helps to reduce very considerably the load imposed by the detector upon the tuned circuit from which it is supplied with signals, so that we must not conclude from the experiment just detailed that it is safe to omit this condenser entirely.

[1] *Journal I.W.T.* Vol. I, No. 4, pp. 148–151.

[2] *The Wireless World.* March 13th, 1929, p. 279.

[3] *The Wireless World.* May 22nd, 1929, p. 524.

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The Pentode as an Anode Rectifier.—

To investigate the connection between the load on the input circuit and the output capacity, the apparatus shown in Fig. 8 was set up. The frame aerial used had an inductance of 225 microhenrys, and the circuit as a whole, including all losses due to the Moullin voltmeter and the dielectric losses due to the pentode rectifier, but

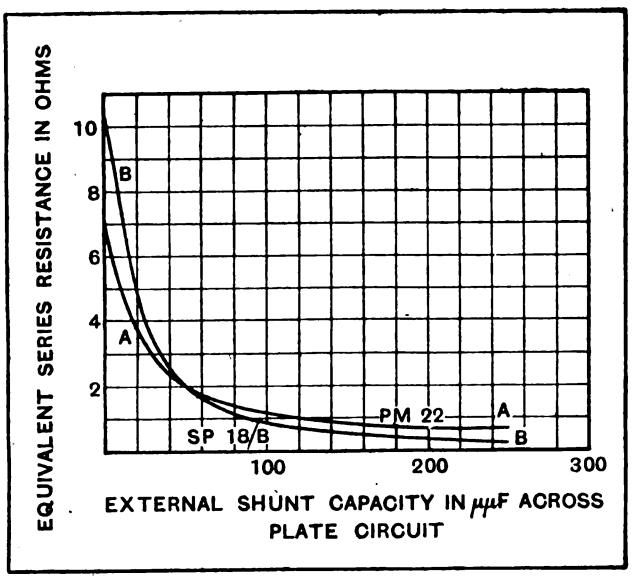

Fig. 9.—Equivalent series resistance introduced by detector with different output capacities. See Fig. 8.

not including any feed-back through the latter, had a high-frequency resistance of 7.9 ohms at the wavelength of 2LO (356.3m.). The resistance r represents one of a series of small high-frequency resistors, any one of which could be put into the circuit at will.

The first step was to tune in 2LO and to read on the Moullin voltmeter the voltage induced by that station across the tuned circuit for a number of different values of the resistance r. During this process the filament of the pentode was not lighted. These results were then plotted as a curve, so that the resistance required at r to reduce the high-frequency voltage to any value within the range of measurement could be read off. Incidentally, this series of readings gave the high-frequency resistance of the circuit that has just been quoted.

Damping in Grid Circuit.

The filament of the pentode, adjusted for rectification ($E_a = 145$v., $E_{aux.g} = 20$v., $E_g = -5$v., $R = 0.22$ megohm), was then lighted, the circuit retuned, and the voltage was read on the Moullin voltmeter for various settings of the calibrated shunt condenser C. For all settings of this, the voltage was slightly lower than had been obtained with the pentode filament unlighted, showing that there was reverse reaction through the grid-plate capacity of the pentode. Each of these voltages could equally well have been attained with the filament of the PM22 disconnected, but with some value of r in the tuned circuit. The value of r equivalent in reducing the voltage to the presence of the pentode was read off from the curve already mentioned, and the results so obtained were plotted, as shown in Fig. 9 (curve A), against the value of external shunt capacity added at C.

As a comparison this series of readings was repeated, the pentode being replaced by a Cosmos SP18/B valve ($m = 35$, $R_o = 70{,}000$ ohms) in order that the damping introduced by the pentode might be compared directly with that produced by an ordinary valve of roughly similar characteristics. Curve B of Fig. 9 shows the equivalent series resistance introduced by this valve for different values of external shunt capacity.

Equivalent Series Resistance due to Damping.

Comparison of the two curves shows that for an external shunt capacity of 0.0001 mfd., which is about the largest value that can be used without audibly sacrificing the higher musical notes, the equivalent series resistance introduced by either of the two detectors examined is in the neighbourhood of one ohm. This damping need not be regarded too seriously, though one would greatly prefer that it should be absent altogether. The result of the damping is shown in another form in Fig. 10, where input voltage, using the circuit of Fig. 8, is plotted against the value of external shunt capacity. The reduction of voltage at the grid of the detector due to the damping that it imposes amounts to about 12 to 15 per cent. with the suggested shunt capacity of 0.0001 mfd.

A separate experiment on the same lines showed that there was no advantage to be gained by connecting a condenser from auxiliary grid of the pentode to filament. The source of current for this circuit, however,

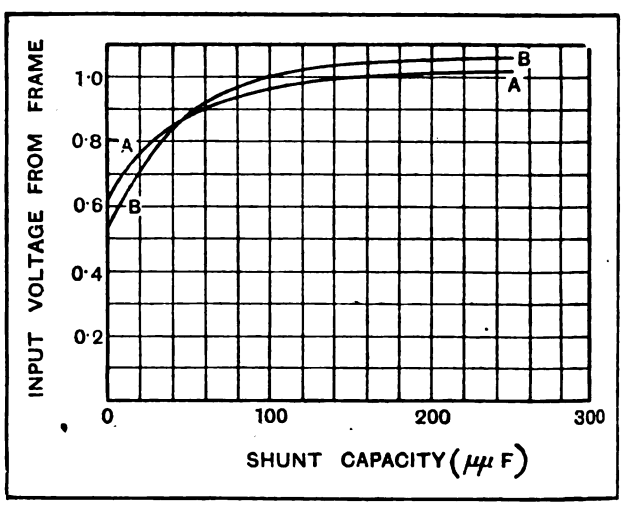

Fig. 10.—Reduction of input voltage due to damping of frame aerial by reverse reaction through the detector. Compare Figs. 8 and 9.

was a small block of H.T. accumulators, in good condition and freshly charged, so that it is probable that the impedance between auxiliary grid and filament was in any case very small, even in the absence of a condenser. If an eliminator were used it would probably be necessary to connect a condenser here also. In any case it would be advisable, in a practical receiver, to decouple this circuit with the usual condenser and resistance, so that the point really does not arise.

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The Pentode as an Anode Rectifier.—

The last measurement made consisted in supplying the pentode with high-frequency modulated at 500 cycles by a low-frequency generator, measuring both the input of high-frequency and the output of rectified "signals." It is not necessary to describe the apparatus used for producing the "signals" for rectification; it amounts practically to setting up a private 2LO for oneself and using it to transmit a continuous "tuning note" from one side of the room to the other. The apparatus is complicated, but perfectly well known to all those who are interested in such experiments.

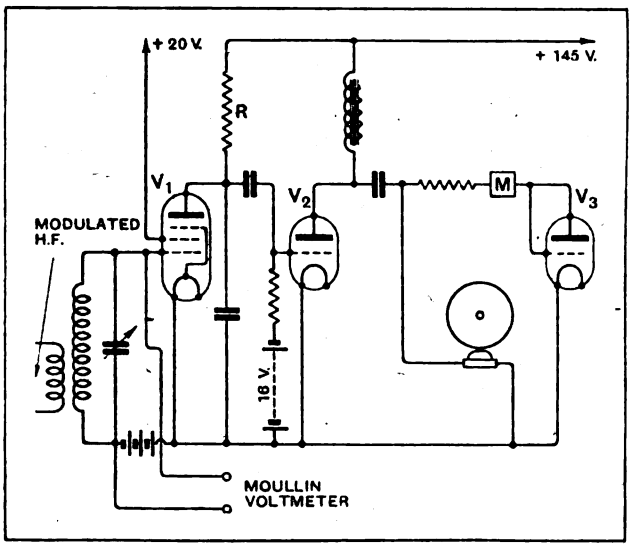

Fig. 11.—V_1 is the PM22 detector, V_2 an amplifier and V_3 together with the meter M, measures the audio-voltage across the loud speaker. The Moullin voltmeter measures the high-frequency input. With this circuit the L.F. output to be expected from the detector for any given H.F. input of normal modulation was determined. See Fig. 12 for results.

The chief difficulty that arises in connection with it lies in determining the degree of modulation in use; for the present purpose this was got over by adjusting the modulation-depth to be approximately the same as that of 2LO when sending out loud passages of dance music. The pentode detector, with its associated valves, was employed in making this adjustment.

Measuring the L.F. Output.

In order to read the low-frequency voltage developed across the resistance in the anode circuit of the valve, an amplifying valve followed by a Taylor voltmeter was used, the two together having previously been calibrated. The detector together with the valves and meters used to measure input and output respectively are shown in Fig. 11. In this V_1 is the PM22 valve adjusted as an anode detector as before, R being again 0.22 megohm. The modulated high-frequency voltage applied to its grid from the miniature transmitter was measured by a Moullin valve voltmeter. The 500-cycle output was applied to the grid of V_2, a D.E.5a valve amplifying in the normal manner. A loud speaker, introduced in order to have an aural check on the proper behaviour of the entire apparatus (11 valves in all were employed, not counting mains rectifiers) was fed from this valve, and the voltage developed across it measured by means of the Taylor voltmeter shown. V_3, the valve forming part of the Taylor voltmeter, was a D.E.R., the meter M being a microammeter. Before connecting the pentode, known 500-cycle voltages were applied to the grid of V_2, and the corresponding readings of M noted, so that the voltage developed across R in the complete set-up could be determined by simply reading M.

Detector Efficiency.

The results derived from all this equipment are given in the curves of Fig. 12, in which the R.M.S. value of the modulated high-frequency input is plotted against peak audio-volts output. Curves are included for two values of anode resistance with the pentode, and for two other valves. The pentode will give, without overloading, an output just large enough to supply a second pentode used in the conventional manner as output valve, requiring for the purpose to be supplied with about 1.3 volts R.M.S. of normally modulated high-frequency. Thus where adequate high-frequency amplification is available, there is no need to interpose a low-frequency stage between the detector and the output valve, even though there is no transformer to provide a little free amplification.

Since the peak value of the high-frequency voltage is about 2.15 times the R.M.S. voltage when the modulation is 50 per cent., this is the largest input with which it will deal. This is indicated in the curves by a tendency to flatten out at the upper ends. The greater output of the pentode, as compared with the triodes, is sufficiently obvious from Fig. 12 to require no further stressing.

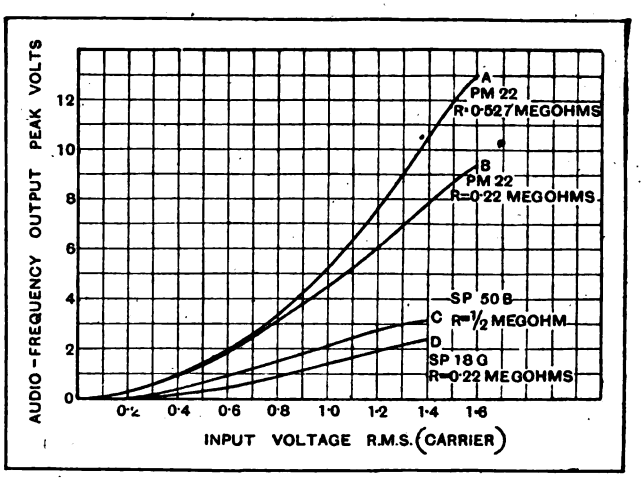

Fig. 12.—Rectified L.F. output from pentode and other detectors supplied with normally modulated high-frequency.

Summing up all that has come to light during these measurements, we may say that the pentode forms an unusually satisfactory resistance-coupled rectifier for small and moderate high-frequency voltages. It is about twice as sensitive as the triode that it replaces, and introduces about the same amount of damping into the grid circuit. In this latter respect, indeed, it might be

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The Pentode as an Anode Rectifier.—

made perfect if the valve makers chose to produce a special model of the valve for this purpose.

With the triode there is no hope whatever of doing away with this unwelcome effect, for it owes its origin to the capacity between grid and plate of the valve. In the pentode, although two grids, earthed so far as signal potentials are concerned, are interposed between plate and signal grid, the capacity between these electrodes remains practically unreduced because the leads to both are taken out at the base of the valve. If the lead to the plate were brought through the top of the bulb, as in the screen-grid valve, and some small attention were paid to screening within the valve, the grid-circuit damping could quite easily be reduced to completely negligible dimensions. If a valve on these lines were produced it would be the first to be specifically designed for rectification since the days of the old soft grid-detector. Two models would be needed, one having figures like those of the PM22 here discussed for resistance coupling, and one with an A.C. resistance of not more than 10,000 ohms for use with a transformer for large inputs. The latter valve at least would also find application in another important direction.

CURRENT TOPICS.

HAPPY PROPHETS.

The enthusiasts who predicted a record success for the 1929 National Radio Exhibition have been more than justified. During the first three days over 40,000 visitors passed through the turnstiles, and the average daily attendance exceeded that of 1928 by nearly 3,000.

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GOOD BUSINESS.

Within a few hours of the opening of the Show enough business had been transacted to cover the entire cost of the Exhibition.

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A NEW HUNTING GROUND.

The B.B.C. test transmission van is now being used in the Glasgow district in a search for a site for the Scottish Regional station. We understand that the Post Office will not contradict the rumour that the van is hunting for "pirates."

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CUTTING OUT THE CACKLE.

Broadcast advertisements are stated to have killed enthusiasm for wireless in Spain. A new State decree, which establishes a system of wireless licences, stipulates that not more than a hundred words of advertisement matter shall be broadcast in one hour.

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SHORT-WAVE PICTURE TRANSMISSION.

Experiments in "Fultograph" picture transmission on short waves are being conducted at Vienna. These tests, which enable definite comparison to be made regarding the relative ranges of telegraphy, telephony and picture telegraphy, take place daily on a wavelength of 41-42 metres. The call sign is UOM, and the following schedule is observed :—

Telegraphy.—10.10 a.m. to 10.20 a.m.
Telephony.—10.20 a.m. to 10.30 a.m.
Picture Telegraphy.—10.35 a.m. to 10.45 a.m.

In the afternoon a similar transmission takes place at 3.10 p.m., continuing until 3.45 p.m. Reports on reception will be welcomed by Fultograph Gesellschaft, M.B.H., Austria, IV Prinz Eugenstrasse 10, Vienna.

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BRITISH WIRELESS GEAR FOR POLAND.

An important success for British industry has been secured by Marconi's Wireless Telegraph Company, Ltd., who have been successful in obtaining one of the largest orders given of recent years in connection with broadcasting services. This order is for a large extension of the Polish broadcasting organisation which, following the English example, is to be remodelled so as to provide alternative programmes for the greater part of the country.

The new equipment will comprise one 120 kW. aerial input broadcasting transmitter with full modulation, two high-power regional stations with 16 kW. aerial input, and three local relay stations. The 120 kW. station will be situated near Warsaw, and will be used in addition to the 12 kW. Marconi station, which is already giving such an excellent service at Warsaw and has been in operation there since 1927.

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MOROCCO JOINS THE MOVEMENT.

The first wireless show in Morocco is to be held from November 30th to December 8th.

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ULSTER SHOW.

The Belfast Wireless Exhibition will hold sway in the Ulster Hall from October 9th to 13th.

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FRENCH LOUD SPEAKER "WAR."

A campaign has been opened in several districts in France against noisy loud speakers. At Châteldon, Puy-de-Dome, an article of French law has been invoked whereby it is an offence to create "nocturnal uproar," even inside a house, if it is audible in the street. A by-law has been created forbidding "open window" loud speakers after 10 p.m.

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BROADCASTING FOG SIGNALS.

To overcome the difficulty experienced by navigators in judging the distance of a fog syren, an interesting experiment in wireless telephony is to be made, probably at the Cumbrae lighthouse, by the Clyde Lighthouses Trustees. After the sounding of each blast from the syren the words "one," "two," "three," will be transmitted at intervals corresponding to the time the sound waves would take to cover one mile. By noting the time lag between the reception of the wireless signal and the sound of the syren, mariners will be able to determine with fair accuracy how far their ship is from the source of sound. At the moment when the syren sounds, the name of the station or lighthouse will be given.

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T.C.C. ELECTROLYTIC CONDENSERS.

We regret that in the Show Forecast in our issue of September 18th the impression was conveyed that the Telegraph Condenser Company, Ltd., had entirely redesigned their electrolytic condensers of the 2,000 mfd. type. This is not the case. The company has, in fact, added to the range by producing a double type of the same condenser with a capacity of 4,000 mfd.

A WARM WELCOME. There have been no "lost children" at Olympia, every visitor being given the opportunity of securing the best Guide to the Show before entering the portals of the Exhibition.

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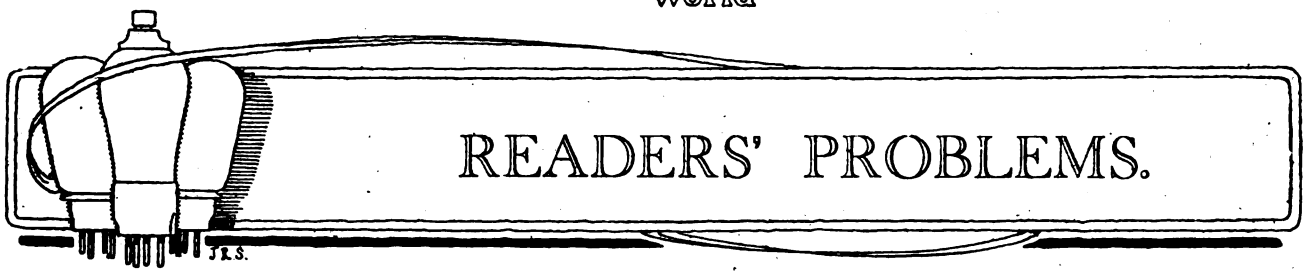

READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

A Selective Two-valve Set.

I have a straightforward direct-coupled two-valve set consisting of a leaky-grid detector with reaction, followed by a transformer-coupled L.F. stage. This functions well on my local station, but the arrangement does not permit me to receive other stations, owing to lack of selectivity. I understand that you have published a two-valve receiver which has a high degree of selectivity, and shall be glad if you would give me the details of this. R. W. G.

A set such as you have in your possession is an extremely unselective arrangement, and it is possible by careful design to produce a receiver having a degree of selectivity greatly in excess of this without in the least sacrificing distance-getting properties, and without appreciable loss of quality.

A receiver of this type was described in full on page 143 of the issue of this journal dated February 6th, 1929. Home-constructed coils were used, and full details were given. In case you do not care for the task of coil construction, you will find that these coils are available commercially.

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Correct Milliammeter Position.

I have a milliammeter with a scale reading of 0 to 50 mA, and have been advised that the correct position for this is between the H.T.– and the L.T.– terminal of the set in place of the usual short length of wire that connects these terminals together inside the set. I have temporarily connected it in this position, but notice that the needle is constantly and regularly fluctuating. The movement of the needle is not large, but the rapidity of the fluctuations are such that the needle appears almost as a blur. Reception is considerably distorted. Can you tell me where I have gone wrong? J. E. G. M.

The sole purpose of putting a milliammeter in the position you show is to enable a reading to be taken of the total current consumption of the set. To leave a meter in this position, however, is wasting its potential usefulness, and, furthermore, it will cause low frequency instability and consequent distortion unless shunted by a large capacity condenser. The trembling of the needle and the distortion you notice are due to the fact that you have inserted the meter in this position without such a shunting condenser. A meter having this scale reading should be connected in the plate circuit of the last valve, where it will act as a useful indicator of overloading of this valve. In order to make quite sure that you place it in the right position, we give a diagram in Fig. 1.

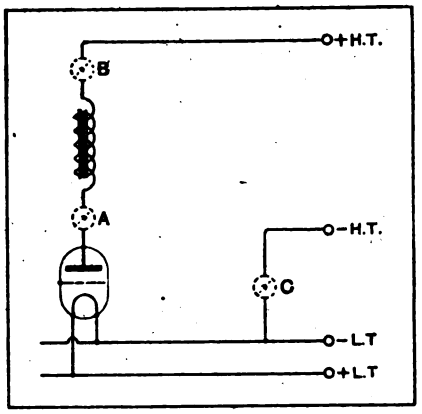

Fig. 1.—Alternative positions for an anode current milliammeter. The correct position is at B.

You will notice that the meter is shown in three positions, (A), (B) and (C). (C) is incorrect for the reason we have just stated; (A) is also incorrect, because the meter is at the high potential end of the external anode impedance. It should be connected at the low potential end of the choke, that is, in position (B).

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Safety First.

Can you give a definite ruling upon the question which has arisen among members of our local radio society as to whether it is necessary to turn the H.T. eliminator off first or to turn the filaments of the valve off first when "closing down" for the night? P. N.

The rule is that the eliminator should be switched off *first*, and when preparing to receive signals again the eliminator should be switched on *last*. In many cases eliminators are designed to avoid this difficulty, and when this is so it is immaterial which is switched off first. It is most imperative, however, that where this safeguard is not provided the eliminator should be switched off before the filaments are turned off, otherwise there is risk of damage to the eliminator, and risk of shock to any person who accidentally touches certain parts of it. The effect of leaving the filaments on for fractional time after the eliminator is extinguished is that the fixed condensers discharge themselves in a normal manner through the appropriate receiver circuits.

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Record III. or New Kilo-Mag Four?

I am thinking of constructing one of the new receivers which have appeared recently in your journal, but cannot make up my mind whether to construct the "New Kilo-Mag Four" or the "Record III," and should be glad of your guidance on this point. I may say that I want long range, but do not desire to sacrifice quality on this account. D. H. G.

The question of which of these two receivers to construct depends solely on whether you wish the set to be operated entirely from A.C. mains or otherwise. Both sets are long-range instruments, and both are productive of good quality. If you have A.C. mains in the house, we should certainly advise the "Record III"; otherwise, of course, the "New Kilo-Mag Four" should be chosen.

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A.C. Valves in the New All-Wave Four.

I have had the "New All-Wave Four" receiver in operation since it appeared in your journal last year. I now desire to use it with A.C. valves, but do not wish to use one of the new screen-grid type valves, but wish to employ an ordinary A.C. triode. Can you tell me what alterations I should have to make? I wish to retain my existing aerial-grid coils and H.F. transformers, if possible. S. F. B.

The best advice we can give you is to refer to you to page 274 of our issue dated September 5th, 1928, where you will find full constructional details of a receiver which is to all intents and purposes the "New All-Wave Four," modified and rebuilt for use with A.C. mains, using a triode, such as you describe. You can use your existing aerial-grid coils and H.F. transformers.

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Pick-up Position.

My present set consists of one H.F. valve followed by an anode bend detector and two stages of resistance coupling. I wish to use a gramophone pick-up, but am uncertain whether to use two or three valves—that is, should the pick-up be used in front of the detector valve or in front of the first L.F. valve? I should be glad if you would decide this point for me. L. L. H.

In your particular case we would certainly advise that the pick-up be used in front of the detector valve. It may be placed in the grid return lead of that valve, but if you intend to insert a jack for the purpose make sure that no fixed condenser present in the set is in parallel with the pick-up, otherwise a loss of high notes will occur.

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Choke Filter Again.

I have constructed a straightforward three-valve set for use in connection with a D.C. mains eliminator; the H.F. valve is coupled to the detector by a transformer of the type used in several of your recent sets. I find, however, that "motor-boating" is very persistent. Can you suggest the cause of this? I enclose a theoretical diagram for your guidance. G. P. R. N.

It is quite a straightforward matter to diagnose your trouble from the diagram. The trouble is evidently due to the fact that you do not use a choke filter output circuit in conjunction with the output valve. In all probability you will find that if this is used the set is completely stable.

We give herewith, in Fig. 2, the connections for adding a choke filter output circuit. There is a right and a wrong way of connecting the loud speaker, and if you adopt the wrong method results will be just the same as though you had not adopted the choke filter. The wrong method is shown in dotted lines. It will be seen that although this method of connection gives the advantage that no direct current passes through the loud speaker windings, thus safeguarding it from breakdown, it still permits the A.C. component of the energy present in the plate circuit of the valve to pass through the source of H.T. supply. A study of the correct method of connection clearly shows that the A.C. energy is almost entirely diverted to filament negative *via* the loud speaker.

With regard to the extra fixed condenser shown in series with the loud speaker, this is not absolutely necessary unless headphones are to be used. If you contemplate the use of long extension leads it is advisable to put in this extra condenser, and its value must be 8 mfd. and the value of the condenser normally in position must also be 8 mfd.

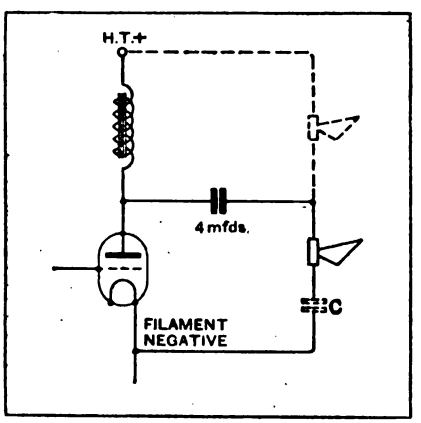

Fig. 2.—Illustrating the correct method of connecting the loud speaker in a choke filter circuit.

The reason is that you have two condensers in series with each other, and although they have this large capacity, the resultant capacity (in accordance with the rule for condensers in series) will only be 4 mfd. You will thus see that if you use one condenser it should have a 4 mfd. capacity, but if you use two, both must be 8 mfd.

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New Valves in a New Set.

I notice that the designer of the "New Kilo-Mag Four" mentioned that in all probability new valves which will be suitable for use with the "New Kilo-Mag Four" will be shortly available. Can you tell me when these are likely to appear? S. R. D.

We would refer you to page 205 of our August 28th issue, where some of these new valves are reviewed.

o o o o

A Pick-up Recorder?

I am thinking of experimenting with the making of gramophone records, and should be grateful if you could tell me the best type of gramophone pick-up to use, and, if possible, inform me how to use it. P. N. M.

You are evidently under the misapprehension concerning the precise function of a gramophone pick-up. This instrument is solely intended to be used in cases where it is desired to convert the acoustic energy from the record into electrical energy so that it may be amplified and passed to a loud speaker which again converts it to acoustic energy. It is impossible to use a pick-up for the reverse process.

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An Accumulator Charging Precaution.

I wish to charge my H.T. accumulators from my mains, which are A.C. Until recently the mains have been D.C., and the job has been done by means of a simple lamp resistance. I propose, in the interests of cheapness, to build the A.C. charger described in your issue of August 3rd, 1927. Can you inform me if this is still to be recommended? G. N. R.

We should not advise you to make use of this instrument now, as it means that the accumulators will be directly coupled to the A.C. mains, and, in view of the regulations that are now in force, it is advisable to use a transformer to isolate the rectifier, and the accumulator on charge. This prohibits the use of a cheap bell-ringing transformer, and means that you must build your instrument with a proper transformer having two secondary windings (we here assume that you are intending to use a valve rectifier).

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Transformer Ratio.

My friend who is constructing a receiver intends to use a moving-coil loud speaker which is wound to a low resistance. He intends using a pentode valve in the last stage, and has requested me to write to you to ascertain whether it would be correct to use one of the many transformers which are specially designed for use after a pentode valve. D. G. L. H.

It is not possible for us to give a definite reply in this case. You will appreciate that in the case of a low "resistance" loud speaker it is necessary that the secondary of the transformer be also wound to a low "resistance," which in the ordinary course of events means a big step-down in ratio. Many of the transformers you mention have only a small step-down and are intended primarily for the purpose of enabling the pentode type of valve to be used in connection with a moving-coil loud speaker of the "ordinary" type, that is, the type wound for use after the ordinary super-power valve. This obviates the necessity of winding the actual coil with a large number of turns.

We advise, therefore, that before purchasing a transformer you ascertain from its makers what type of loud speaker is intended to be used in conjunction with it.

You will appreciate that in order to "match" the output valve or valves with the loud speaker it is really necessary to use an output transformer whose primary is wound to harmonise with the output valve or valves, and whose secondary is wound for use in conjunction with the particular *type* of loud speaker concerned. You will perceive from this that the ratio of the transformer then automatically settles itself.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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TELEVISION.

THE past week has seen the inauguration of experimental transmissions of the Baird system of television from the B.B.C. London station, 2LO, but the number of people who are the wiser now that these transmissions have begun is very limited indeed, and the whole position appears to us to be so absurd that we wonder whether the inauguration of these experiments is really intended to be taken seriously or not. Those who have witnessed Baird television demonstrations in the past will know that only two or three people can "look in" at a time to one instrument, and there are, we understand, at the very most half a dozen instruments set up in this country to receive the B.B.C. transmissions. Add to this the fact that the transmissions are being conducted at 11 o'clock in the forenoon—a time when very few of those likely to be interested in the development of television are able to avail themselves of the transmissions—and we have altogether a collection of very good reasons why television is not likely to make much progress in this country at present.

The Baird Company are not at present undertaking to manufacture television receiving sets; their object appears to be to endeavour to establish a patent situation under which they license radio manufacturers generally and draw royalties on every receiver sold. This is no doubt a policy which it is thought will, in the end, be to the advantage of the Baird Television Company's shareholders, but in the meantime manufacturers are, quite naturally, in no hurry to sign a licensing agreement which will presumably tie them up to paying royalties over a period, whether or not they may be dependent on Baird patents in the manufacture of receivers. The only way in which we can foresee success attending the efforts to launch television is if these efforts are wholehearted, and there is a genuine endeavour made to rouse enthusiasm on all sides. The Baird Company will gain nothing by stifling the project at the outset because they desire to guarantee their own participation in the financial gain which may accrue, neither can we expect any headway to be made so long as the B.B.C. conduct the experimental transmissions at a time when the amateurs and experimenters who are most likely to provide the enthusiasm needed to carry the thing through are unable to participate in the tests. It would be far better that the transmissions, or at least some part of the transmissions, should take place in the evenings or over week-ends, for that is the only way in which publicity amongst enthusiasts can be attained and when it will become possible for them to co-operate in the experimental transmissions and probe the possibilities of the system.

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OLYMPIA SHOW COMPETITION.

AT the time of writing, a few days still remain before the entry forms for *The Wireless World* Olympia Show Competition are due to be received, but already a large number of early entries are reaching us. We anticipate that it will not be possible to announce the result of the ballot for two or three weeks, owing to the time required in the task of sorting out the votes and ascertaining the winners in each class.

Meanwhile, we hope that every reader has participated in the ballot by completing an entry form to send us. As soon as results are known they will be announced in *The Wireless World*, and the prizes will be awarded, whilst the winning apparatus will be reviewed in the pages of this journal.

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TRANSMITTING ON ULTRA-SHORT WAVES

By R. L. SMITH-ROSE, D.Sc., Ph.D., A.M.I.E.E., and J. S. McPETRIE, B.Sc.

Experimental Transmitting Apparatus for Wavelengths below 10 Metres.

ALTHOUGH it has been possible for some time past to generate on a laboratory scale oscillations of a frequency corresponding to wavelengths below 10 metres, the introduction of such wavelengths into commercial communication is taking place very slowly. This is partly due to difficulties in the technique of generation with appreciable power and the construction of sufficiently sensitive receivers, and partly to the very limited range which can be obtained in the transmission of such waves directly along the ground. Communication over anything but the shortest distances must therefore take place by means of waves transmitted through the atmosphere, and although this has been stated at times to be impossible a small amount of evidence to the contrary is now becoming available. With a view to assisting those readers who may care to experiment on the ultra-short wavebands, this article contains a brief description of some experimental transmitting apparatus which has been constructed and made to work; a further article describing a simple receiver for such short wavelengths will, it is hoped, be published later.

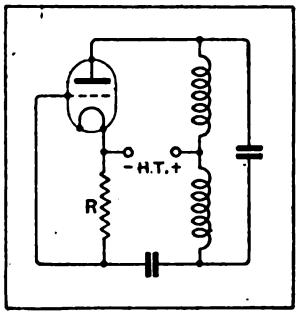

Fig. 1.—Circuit diagram of single-valve oscillator for very short wavelengths. The D.C. supply connections are omitted for simplicity.

It may be said at the beginning that very few, if any, new principles have to be learnt and followed in the construction of short-wave apparatus, provided that due allowance is made for the change of frequency in regard to the effect of reactances, mutual couplings, etc. It has to be realised, for instance, that at a frequency of 100 million cycles per second, the reactance of a straight piece of No. 47 S.W.G. Eureka wire may be much more important than its ohmic resistance, and that when a straight wire is arranged in the form of an aerial and is tuned to the working frequency the radiation resistance is usually the predominating factor which limits the current flowing in the aerial.

In the design of a valve transmitter it is natural to give early consideration to the actual type of oscillating valve circuit which it is proposed to employ. In a more comprehensive paper published in the current number of *Experimental Wireless* a somewhat detailed study is given of the various sorts of circuit of both the one-valve and two-valve type, with a discussion of their relative suitability for work at extremely high frequencies. One of the most important precautions to be taken in the construction of short-wave transmitters is to ensure that the coupling *via* the inter-electrode capacities of the valve is assisting the coupling due

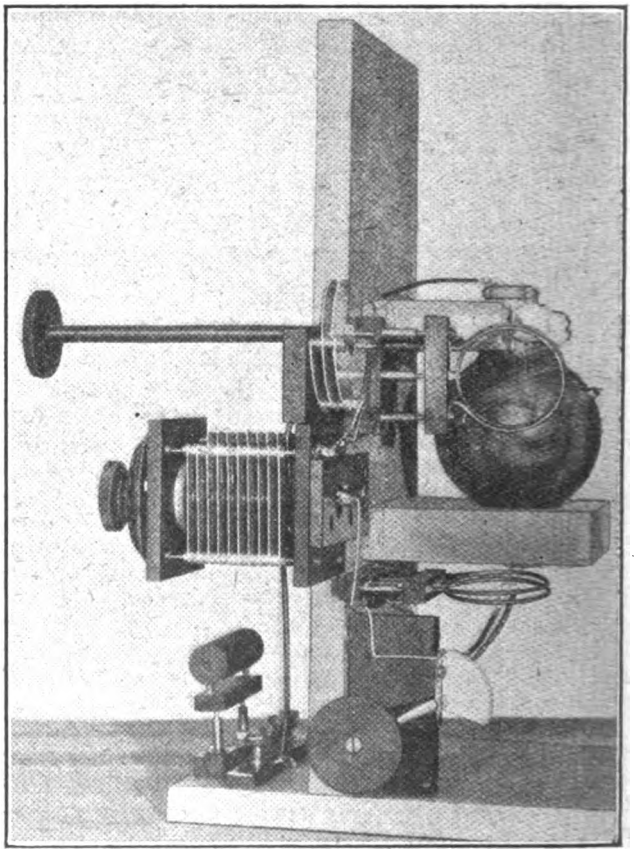

Fig. 2.—Single-valve transmitter for wavelengths down to 5 metres, employing a 100-watt valve in the circuit of Fig. 1.

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to any mutual inductance whether stray or intentional. Many layouts of an otherwise useful circuit will not oscillate for the sole reason that these couplings are opposing each other.

A Single-valve Transmitter.

A most useful single-valve circuit for short-wave working is that sometimes known as the series-fed Hartley circuit illustrated in Fig. 1. Before attempting the construction of a transmitter based on this circuit it is important to get a clear idea of the magnitudes of inductance and capacity which are available for work on the wavelengths in question. To crystallise the reader's ideas it may be stated that a single turn loop of thick copper wire about 12in. diameter has an inductance of less than one microhenry, and that this requires only 36 micro-microfarads of capacity to tune it to a wavelength of 10 metres, or 9 micro-microfarads to tune to 5 metres. There is, therefore, not much to spare in the matter of inductance and capacity, and every effort must be made to keep the dimensions of the subsidiary portions of the valve circuit as small as possible in order that the bulk of the small inductance and capacity available may be in the main oscillatory circuit.

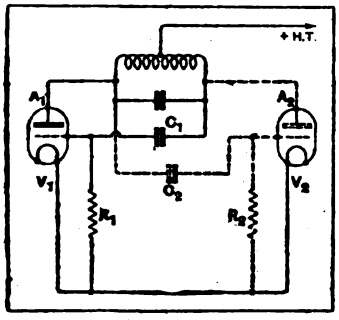

Fig. 3.—Circuit arrangement of two-valve oscillator showing its derivation from the series-fed Hartley circuit of Fig. 1.

Reverting to the circuit diagram given in Fig. 1, it is to be observed that a centre tapping point is required on the inductance loop. While this may be made at the top of a single turn loop it is usually more convenient to use a two-turn loop in order to bring the tapping to the bottom of the coil where connection has to be made to its ends. In order to cover different ranges of wavelength it is convenient to mount these two-turn coils on small insulating blocks with three pins giving connections to the ends and centre of the coil. A single-valve transmitter employing a 100-watt valve in a circuit arrangement similar to that of Fig. 1 is shown in the photograph in Fig. 2. The transmitter is mounted on a panel of American whitewood, which material has a very low dielectric loss when kept dry. The main inductance is the two-turn loop to be seen in front of the valve. This is formed of No. 14 S.W.G. copper wire into a coil 2½in. in diameter, mounted on an ebonite block with the necessary three-pin connection. This coil is mounted directly on its tuning condenser, which contains two moving and three fixed plates as shown, and has a capacity of about 20 micro-microfarads. It will be noticed that an extended control handle is provided for this condenser in order to minimise hand capacity effects when tuning. The larger variable condenser seen to the left of the photograph is used for variable retroaction. As shown, this condenser is unnecessarily large and its capacity, while not being very critical,

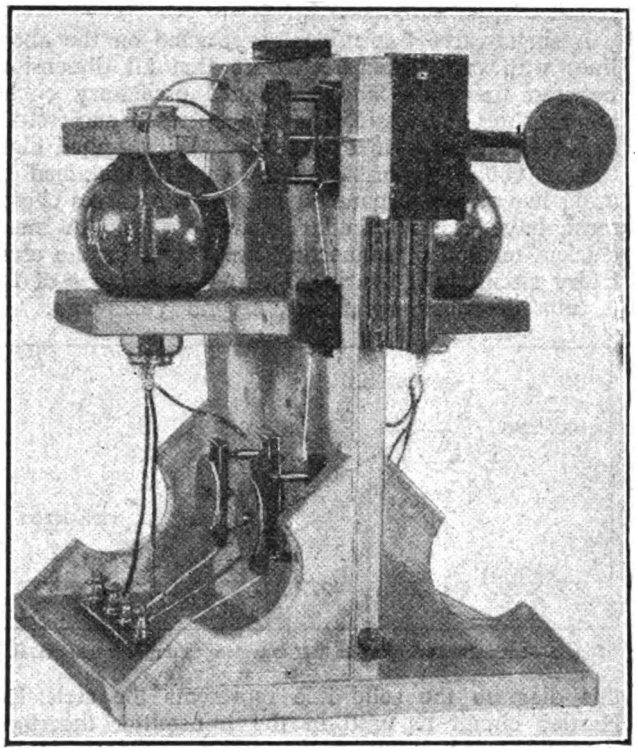

Fig. 4.—Two-valve 200-watt transmitter, wavelength 5 to 30 metres, using the circuit of Fig. 3.

need only have a maximum value of 100 micro-microfarads. The two-turn coil mounted horizontally beneath the valve formed, with the variable condenser below it, a rejector circuit in series with the grid leak. This was originally inserted as a means of ensuring that the self-capacity of the grid leak itself did not cause difficulties, but later experience has proved that it is difficult to use it effectively owing to the fact that it provides another circuit to tune, and that it is more convenient and practically as effective to do without it or replace it by a choke coil. Owing to the symmetry of the circuit the positive H.T. supply lead does not really demand the insertion of a radio-frequency choke coil, but this and most other arrangements can be used more effectively on the shortest wavelengths when such a choke is used. Very little knowledge is available as to the behaviour of chokes at very high frequencies. A useful design, as shown in Fig. 2, consists of from 100 to 150 turns of No. 47 S.W.G. copper wire wound at uniform spacing on a three inch former of ebonite of American whitewood one inch in diameter.

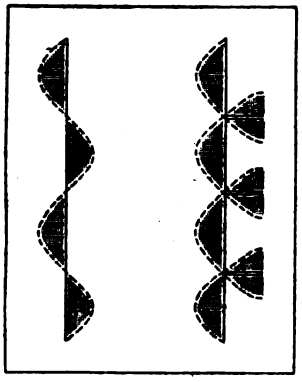

Fig. 5.—Diagram showing the use of phasing coils in an aerial two wavelengths long to give maximum radiation in a horizontal plane.

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A single-valve transmitter constructed on the above lines with care taken to ensure that all dimensions between the valve and the tuned oscillatory circuit are as short as possible can be operated successfully at wavelengths down to 4 metres. With limited high-tension voltage increased output may be obtained by using two valves in parallel, but the two valves chosen must have closely similar characteristics. A more efficient method of connecting two valves to one oscillatory circuit is shown in Fig. 3, which is one of the circuits described by Eccles several years ago. In

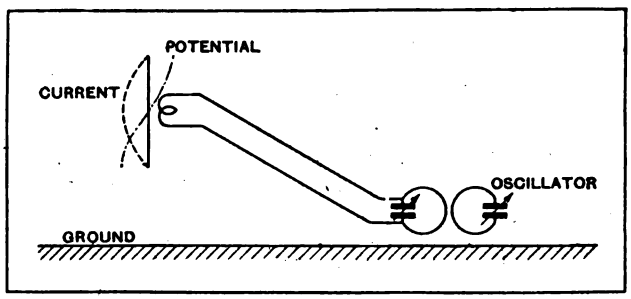

Fig. 6.—Inductive coupling to half-wavelength ungrounded aerial.

this diagram the solid line represents the series-fed Hartley circuit as used in the transmitter described above. The broken line shows the manner in which the second valve is connected. It will be seen that this circuit is really a double series-fed Hartley circuit, the two valves of which supply the oscillatory circuit alternatively. Each valve in such a transmitter may be tested individually under working conditions by converting the oscillator in succession into its two constituent single-valve circuits, and testing each in turn. Some readers may prefer to consider the two-valve circuit as one, operating on the familiar "push-pull" principle, with variable capacity coupling between the anode and grid coils.

200 Watt Transmitter.

A short-wave transmitter of 200 watts input designed to work on wavelengths between 5 and 30 metres with the circuit arrangement of Fig. 3 is illustrated in the photograph, Fig. 4. The whole of the transmitter, less the direct-current supplies, is mounted on an American whitewood panel as shown. The valves are placed on opposite sides of the panel in order to shorten, as much as possible, the leads between them. Although the anode current is really fed in at a constant potential point of the oscillatory circuit it is desirable to insert choke-coils in the high-tension supply leads in order to ensure that no high-frequency power loss occurs in these leads. Various sizes of condenser have been tried for coupling the anode of one valve to the grid of the other, and the most suitable has been found to be a variable condenser having a maximum capacity of about 50 micro-microfarads. The main tuning condenser should preferably have a somewhat smaller capacity.

The coils forming the inductance for such a transmitter may be constructed either of copper rod about $\frac{1}{8}$in. diameter, or of aluminium tube of a larger size. The dimensions of the coils are so small that the ohmic resistance is not very important, but it is desirable to have a substantial size of conductor in order to secure rigidity, and so avoid slight changes in wavelength due to vibration. The variable condensers employed may be constructed conveniently from the standard low-loss transmitting type with some of the plates removed and additional spacing washers inserted. Every effort should be made to obtain a very low minimum capacity, if the shortest wavelengths are aimed at.

A similar type of transmitter, employing two 250-watt valves will be found described and illustrated in the paper published in *Experimental Wireless* referred to above. It may also be recalled that a portable transmitter employing two valves arranged in the push-pull connection of Fig. 3 was described in *The Wireless World* about a year ago.[1] In this case, however, the minimum wavelength was about 30 metres, and two L.S.5A valves were employed, capable of handling a power input of 20 watts.

Valve Requirements for Transmitters.

Valves intended to deal with power at very high frequencies must have special design features not essential for those working at lower frequencies. The first feature desired is low self capacity and mutual capacity of the electrodes. This means that the leads to the electrodes should be brought out of the glass envelope as far as possible from one another. This separation of the leads, however, is limited by the inherent increase in inductance due to their greater length.

Several years ago Franklin drew attention to the possibility of the glass envelope melting as a result of the heat generated by eddy currents in metallic deposits which occur on the inside of the glass during evacuation of the valve. In certain types of transmitting valves

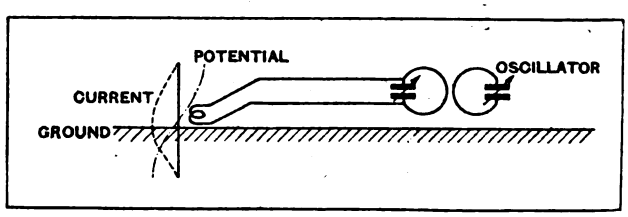

Fig. 7.—Inductive coupling to grounded quarter-wave aerial.

it has been customary to use copper foil screens on the outside of the envelope to avoid breakdown from this cause. Large dielectric losses may also be experienced in those portions of the glass which lie within the high frequency field between the grid anode. The envelope should, therefore, be of as great dimensions as is consistent with short leads from the electrodes. The neck of an ordinary transmitting valve is in a concentrated part of the field and punctures were very common at this point when valves were first used on short wavelengths. The field may be reduced by continuing the grid mesh beyond the ends of the anode. This construction concentrates the radio-frequency field between the grid and anode, and so reduces that which reaches

[1] *The Wireless World*, October 10th, 1928, page 501.

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the glass walls of the valve. It is also advisable to thicken the leads to the electrodes at the places where they enter the glass.

Aerials and Signalling Arrangements.

The portable transmitter referred to above was connected to a short aerial through a variable coupling condenser from one end of the oscillatory circuit, an earth connection being taken to the centre point of the inductance, at which point the high-tension direct current is also supplied to the circuit. While this method may still be employed for wavelengths below 30 metres, it is found that when the wavelength is less than 10 metres only a very short aerial is available if the difficulties of phasing in alternate half wavelengths are to be avoided. For example, on a wavelength of 5 metres a 30ft. aerial is about two wavelengths long, and the distribution of current therein will be as shown in the left-hand side of Fig. 5, where the distance of the wavy line from the vertical line indicates the magnitude of the current, and the shading and the side of the aerial on which it is placed indicates the direction of this current. It is seen from this diagram that there are two equal loops of current of each of the two opposite directions, and there will thus be no field due to the whole current in a direction perpendicular to the aerial. From this it results that there will be no radiation from such an aerial in the horizontal plane, although there will be some radiation in other directions. By inserting suitable inductances in the aerial the distribution of current in successive portions of the aerial may be altered as indicated in the right-hand diagram of Fig. 5. It is now seen that throughout the length of the aerial the currents are all in the same direction, and will thus assist each other in producing strong radiation in the horizontal plane. This is the method successfully employed at the Marconi beam stations, where aerials of several half-wavelengths in height are employed.

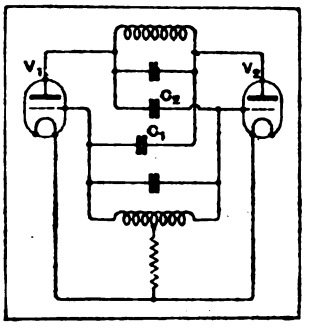

Fig. 8.—Circuit diagram of an alternative push-pull oscillator employing tuned circuits in both anode and grid circuits.

In order to avoid the complications arising from the use of phasing coils in the above manner it is convenient in experimental work on very short waves to employ short, straight aerials the length of which corresponds to either a half or a quarter of the working wavelength. In the former case the aerial should be supported at a suitable distance above the ground, the ends being insulated, since these are the points of high potential variations. The aerial may be energised by inductively coupling the oscillator to a point near its centre, as indicated in Fig. 6. In the case of the quarter-wave antenna, this should be connected either to earth or to a suitable counterpoise at its lower end, at which point the maximum current will be obtained (Fig. 7). For efficient radiation on very short wavelengths the antenna should be situated in as open a space as possible. In the radiated field objects act as reflectors when their linear dimensions are comparable with the working wavelength. The buildings associated with a short-wave station are usually such that they give rise to an appreciable amount of scattering and loss. The only method of diminishing the loss of useful radiation in this manner is to place the aerial at some distance, two or three wavelengths, from any buildings and supply energy to it from the transmitter by means of a transmission line. Such a line may be formed either of a pair of straight, parallel Lecher wires, or of a twin conductor comprising an inner wire surrounded by a concentric metallic sheath. In either case the line should be such that it has maximum current loops at each end, which is obtained when the length of the line is an integral number of half wavelengths. A line of fixed length may, however, be effectively varied by tuning it with variable condensers at one or both ends, as indicated in Figs. 6 and 7, which show the principles of feeding half- and quarter-wave aerials through transmission lines. A Lecher wire transmission line may be conveniently formed of two copper wires of about No. 16 or 18 S.W.G. stretched parallel at three or four inches apart, and at a distance of at least a foot from all other bodies except their supports. The wires are short-circuited at each end and adjusted either by length or by varying the condenser to obtain maximum current at each end.

A half-wave antenna may conveniently consist of two telescopic brass or aluminium tubes supported at the centre. This antenna is tuned by altering its length, the current being observed on a suitable thermal ammeter inserted at its middle point where the current is a maximum. Owing to the fact that the radiation resistance of a half-wave antenna is in the neighbourhood of 80 ohms, the actual ohmic resistance of the antenna, including the ammeter, is not of serious importance. In a recent experiment the replacement of an antenna of ½in. brass tube by a No. 30 S.W.G. Eureka wire only reduced the current by 30 per cent. On account of this high effective resistance the tuning of a half-wave antenna is not very sharp. Since, however, the radiation resistance is the predominating factor limiting the current, the efficiency of such an aerial is very high, and practically all the energy supplied to it is converted into useful radiation.

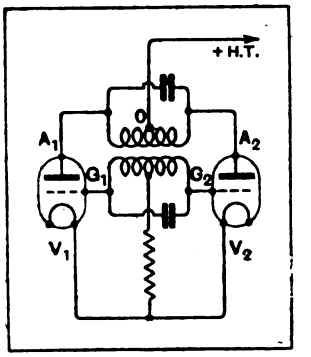

Fig. 9.—Circuit of Fig. 8 with the coupling condensers omitted. The necessary coupling is obtained by the mutual inductance of the tuned circuits.

The variable condensers in the Lecher wires form a useful method of altering the current in the aerial without disturbing the balance between the two valves of the oscillator. The Lecher wires are useful in addition for measuring the wavelength, which can be carried out approximately by running a shorting wire bridge along

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the wires. This alters the current in the aerial except when the bridge is at a potential node on the wires. The positions of consecutive potential nodes are one half-wavelength apart, and can be determined to within about 1 cm. An alternative method of locating these potential nodes is to bridge the wires with a small thermo-galvanometer to determine the positions of maximum current. In either case these positions can be determined with fair accuracy, since at the points in question there are practically no radio frequency potentials, and body capacities will therefore have little

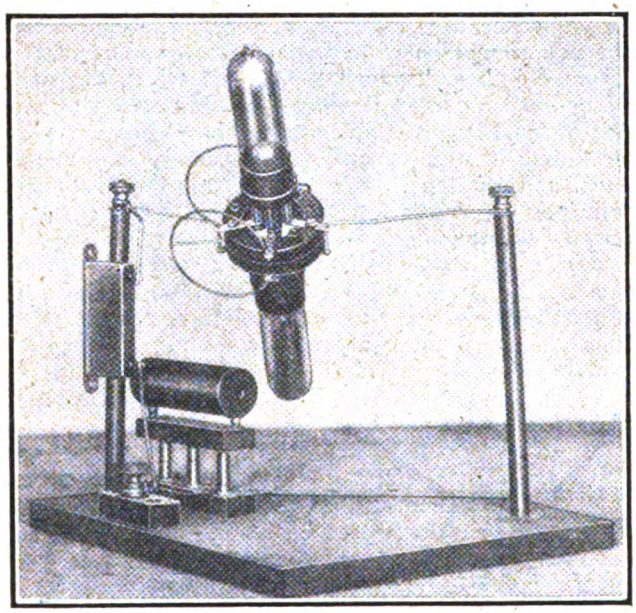

Fig. 10.—Two-valve oscillator using the circuit of Fig. 9 and operating on a wavelength of 1.8 metres.

effect. The whole Lecher wire system should, however, be erected as far as possible from all other bodies in order to avoid spurious effects due to the proximity of these at potential antinodes on the wires.

Signalling.

Signalling with low-power short-wave transmitters may be carried out by using a suitable key in the high-tension supply as with the portable set already referred to, or by short circuiting a small coil placed near the tuned oscillatory circuit. The tuning of a receiver at wavelengths of the order of 5 metres is so sharp that the change in the frequency of the transmission brought about by the latter method is sufficient for the signal to become inaudible in the receiver when the coil, coupled to the tuned circuit, is short-circuited. An alternative method of keying for signalling purposes is to attach one terminal of a transmitting key to one wire of the Lecher system, and simply to operate the key by means of a long handle. The closing of the key contacts adds a small lumped capacity to the Lecher wires, which is sufficient to change the heterodyne note in the receiver. Keying by this method produces extremely clear signals and does not alter the load on the transmitter to any appreciable extent.

An Oscillator for Extremely Short Waves.

In the two-valve "push-pull" circuit described above, and illustrated in Fig. 3, grid leaks R_1, R_2 were employed to fix the D.C. potentials of the two grids. A suitable value for the resistance of these leaks has been found to be 0.5 megohm, although this value is not so important as the self-capacity, which should, naturally, be kept as low as possible. It has been found that for low-power work leaks of the deposited metallic-film type are suitable. A consideration of Fig. 3 will show that the circuit will oscillate just as well if the grid leaks are replaced by any circuit which has a high impedance at the frequency of the oscillator. For example, R_1, R_2 may be replaced by chokes, the D.C. potential of the grids being fixed by a suitable resistance in the common lead from the filament to the common point. Another method of having a high impedance between the two grids is to replace R_1 and R_2 by a tuned circuit, as shown in Fig. 8, which is another of the two-valve balanced circuits first described by Eccles and Jordan. The connection to the filament, in this case, is made to the middle point of the inductance. Suitable choke coils may be of the single-layer solenoid type described above in connection with the circuit details relating to Fig. 2.

In the double-valve oscillator of Fig. 3 the condensers C_1 and C_2 act as retroaction condensers from the anode of one valve to the grid of the other. In the circuit in Fig. 8, however, these condensers are not required, as the mutual inductance between the anode and grid coils may be made to provide the necessary retroaction. The diagram of such a circuit is given in Fig. 9. This type of oscillator has the disadvantage that there are two circuits to tune, and that it is difficult to vary the coupling between the grid and anode coils when working on very short wavelengths. At very high frequencies the electrostatic coupling between the grid and anode coils may become important, and this coupling is of opposite sign to that intentionally introduced by the magnetic induction. With the two-valve oscillator using the circuit shown in Fig. 9 it has been found possible to obtain oscillations at various wavelengths down to a lower limit at about 1.5 metres. This limit is really set by the dimensions of the valves and the time taken by the electrons to travel from filament to anode inside the valve. Fig. 10 shows a view of a two-valve oscillator which operates on a wavelength of 1.8 metres. Two short-path receiving valves are mounted on low capacity holders "back-to-back." The inductances are formed of loops of No. 16 S.W.G. copper wire about 2in. in diameter, and all subsidiary connecting wires are reduced in length to the minimum, and no tuning condensers are used.

The high tension feed is through a piece of No. 47 S.W.G. Eureka wire which acts as a choke and fuse combined. A choke coil is included in the grid lead, while a condenser of 0.01 microfarad capacity is provided.

It is, of course, very difficult to obtain any appreciable output from such oscillators, and when an attempt is made to increase the power by the use of larger valves it is usually found that the minimum wavelength attainable increases.

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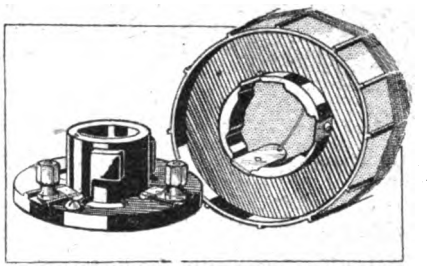
The New Kit Sets

Home Constructors' Receivers Seen at Olympia.

WHAT is a "Kit" set? Strictly speaking, this description should be applied only to complete sets of parts for receiver construction, but it has, very conveniently, been extended to cover circuit arrangements sponsored by various manufacturers who, although they issue descriptive literature, do not supply all the necessary components. This scheme offers what is, in some cases, an important advantage; existing pieces of apparatus in the possession of the constructor may be used.

Indications are not lacking that the building of sets in this way, involving as it does nothing beyond the assembly and wiring of a few readily obtainable parts, is increasingly popular, and the Olympia Exhibition showed that an infinitely greater diversity of kits are now available than at any previous time. Last season's sets have undergone modifications in much the same way as have complete commercial receivers, and there has been a distinct tendency to improve their performance, to simplify their operation, and to render their construction even easier than previously.

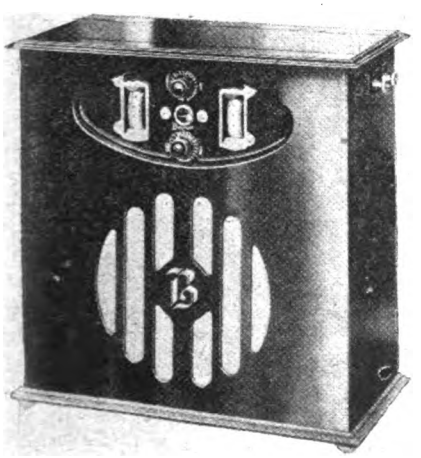


Non-reversible mountings for interchangeable coils in the Brown receivers.

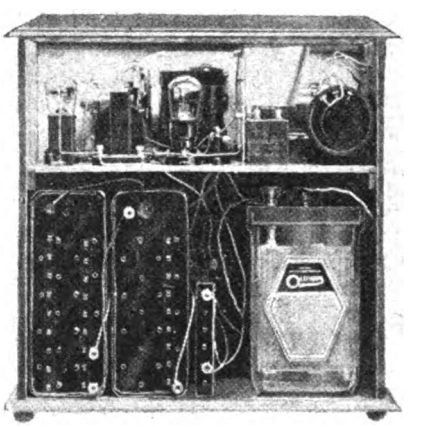
With one or two exceptions, all the sets offered are three-valve H.F.-det.-L.F. combinations; indeed, it is becoming more and more apparent that this excellent circuit arrangement is regarded as a standard one for meeting average requirements. Perhaps the most striking innovation is the introduction of kits for A.C. mains operation—not simply ordinary battery sets arranged to be more or less capable of working with an H.T. eliminator, but receivers designed specifically for this form of supply for their filament and anode circuits.

The purpose of this article is briefly to describe the principal features of sets that are either entirely new this autumn or that have undergone considerable modification, and no attempt will be made to treat anything but the main features of the various designs: detailed descriptions and test reports will, no doubt, in most cases, come at a later date.

The Brown sets, recently introduced by the well-known firm of loud speaker manufacturers, are typical of present-day tendencies in several respects. Four distinct models are available; two for battery feed and two for mains supply. Each type is



Brown three-valve set, complete with loud speaker.



Interior view of Brown kit set, showing how batteries are mounted behind the loud speaker.

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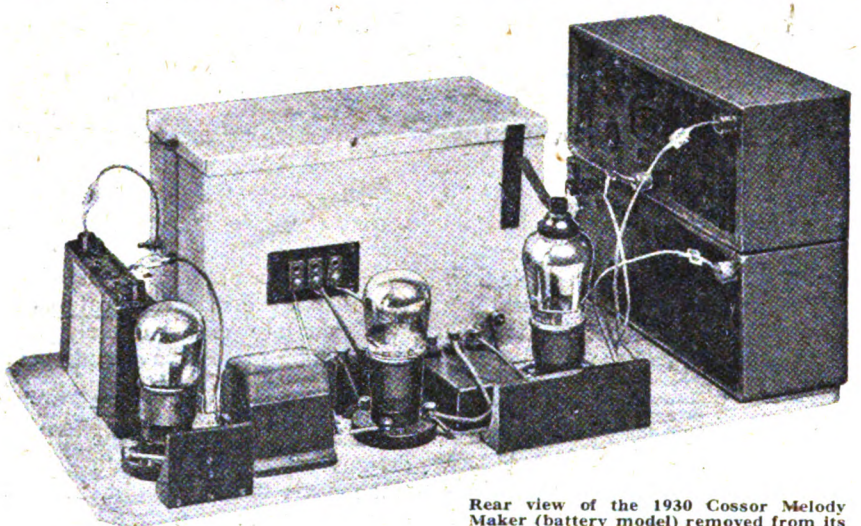
The New Kit Sets.—available with or without a built-in cone loud speaker. In every case there is ample room inside the containing cabinet for batteries or mains unit. The circuit arrangement embodies a single H.F. amplifying stage (screen-grid valve), grid detector, and an output valve coupled by means of a Brown Type A low-frequency transformer. Reaction is provided, and the tuning condensers are controlled by edgewise dials.

Interchangeable coils, wound on large ribbed bakelite formers, are used. These coils are provided with a particularly good form of bayonet catch mounting, of which the studs look as if they should be entirely free from that annoying form of trouble due to intermittent contact. The aerial-grid coils have three separate aerial tappings, brought out to sockets mounted on the former itself in such a way that an adjustment of coupling may readily be made to suit varying needs in the matter of selectivity. It should be added that the coil mountings are so arranged that they cannot possibly be inserted incorrectly in their holders.

The new "Bullphone" kit sets are supplied with bakelite panels, into which are moulded the necessary holes for securing the various components. The "Nightingale Three" is a detector-2-L.F. receiver with transformer coupling, while the "Screened Grid Three" embodies an H.F.-det.-L.F. circuit. The dual range coils used have built-in switches operated through rods projecting through the panel.

A New Departure.

The "1930 Cossor Melody Maker" has been completely redesigned, and bears but little resemblance to its prototype. It will be generally agreed that the majority of home constructors' difficulties are in some way associated with the H.F. stage; here a bold attempt has been made to remove possible causes of trouble by supplying all the apparatus associated with this part of the receiver—coils, tuning condensers, reaction condenser, wave-range switch, etc.—as a complete manufactured and wired unit, contained in a two-compartment screening box for mounting inside the cabinet. Advantage has been taken of the fact that this method of construction lends itself to "ganging" of the two tuned circuits, and consequently we find that they are controlled by a single knob.



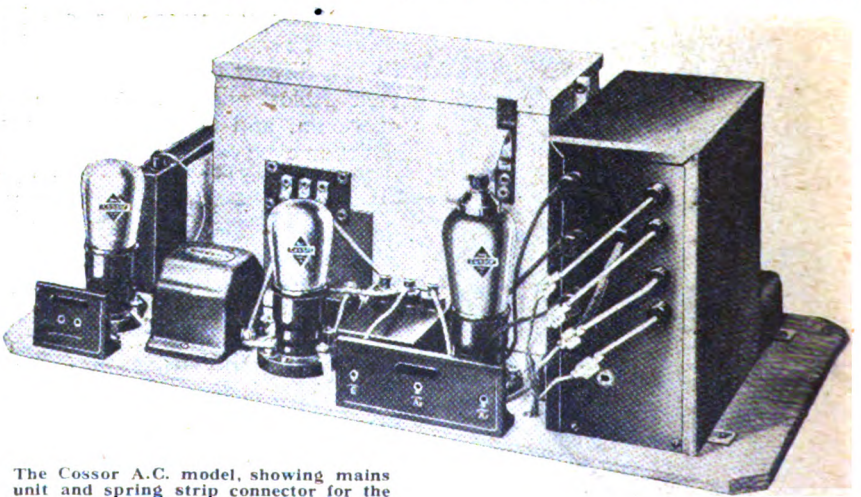
Rear view of the 1930 Cossor Melody Maker (battery model) removed from its containing cabinet. Note the screened H.F. unit.

The circuit arrangement embodies the conventional H.F.-det.-L.F. combination, but double-wound transformers are used as H.F. couplings. As the H.F. unit is ready wired when purchased, it will be appreciated that the work remaining for the home constructor is considerably lightened, and is still further simplified by the provision of such refinements as a spring connector for the H.F. valve anode terminal and an aerial series condenser moulded into the terminal strip. Waveband changing is effected by a three-position switch which also controls the filaments.

Another distinct model for A.C. mains operation is supplied; it differs from the battery set only in details, and includes a factory-made power unit which fits the space inside the cabinet occupied normally by the H.T. battery. Directly heated A.C. valves are used in this set.

Ferranti Sets.

The Ferranti "Screened Grid Three" has been modified in details, and now includes a volume-control resistance connected across the primary of the L.F. transformer: separate decoupling resistances and condensers have been replaced by the new anode feed units, in which the two components are combined.



The Cossor A.C. model, showing mains unit and spring strip connector for the H.F. valve anode.

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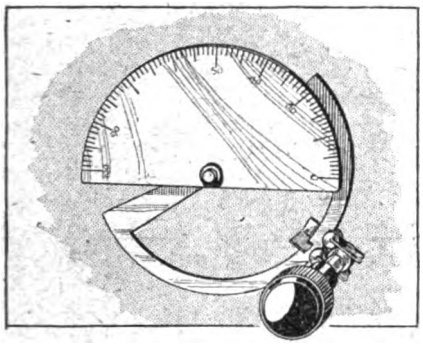
The New Kit Sets.—
Tuning condensers of 0.0005 mfd. are now used.



Reduction gear drive for the ganged tuning condensers of the new Cossor kit set. A system of friction wheels operating on a metal arc is employed.

A new kit set, with one H.F. stage and anode bend detection followed by two L.F. amplifiers with push-pull output has been introduced. A pick-up jack is fitted, with contacts so arranged that insertion of the plug will switch off the H.F. valve filament, insert the pick-up in the detector grid circuit, and also short-circuit one of two feed resistances connected in series with the detector anode, thus increasing its H.T. supply voltage, and consequently making this valve act as an amplifier without alteration of its grid bias.

Since it was reviewed in these columns, the Formo "S.G.3" has not been altered to any extent, although a minor improvement has been effected by fitting tuning dials of a new pattern.

The Lewcos "Chassis."

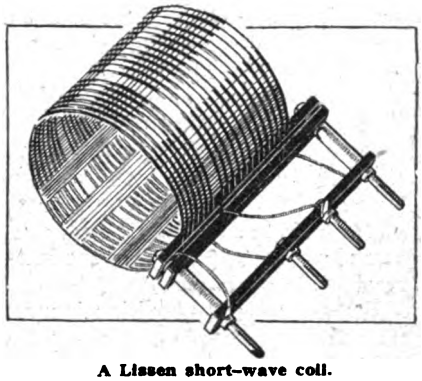
The Lewcos "Kit Assembly" is so nearly a complete receiver in itself that it might perhaps be described as a chassis rather than as a kit. With the exception of three variable condensers and an on-off switch, it comprises all the components of a conventional H.F.-det.-L.F. receiver. All these parts are mounted on a bakelite base, and are completely wired. Transformer coupling is used for both H.F. and L.F. stages. By fitting sockets for indirectly heated valves and a link for making the necessary alteration to the heater or filament circuit, the set is made suitable for either battery or A.C. mains operation.

An unusual method of waveband changing is used in the Lewcos set; the blocks carrying the aerial-grid and intervalve coupling coil assemblies are mounted in guides so that they can be moved bodily by means of push-rods: the connections of the coils are changed through contacts mounted on the underside of the movable bases.

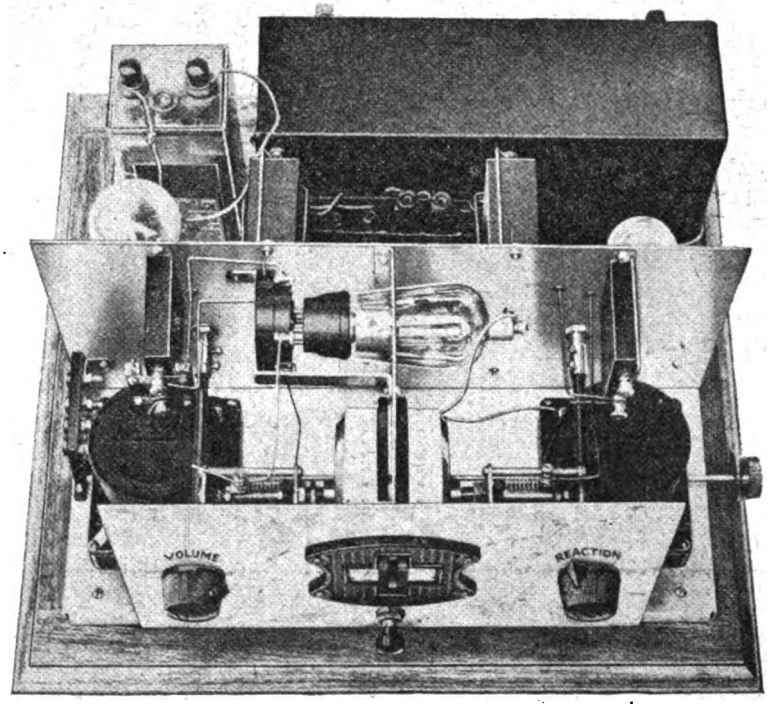
A Kit Set Brought Up to Date.

The Lissen H.F.-det.-L.F. set is substantially unchanged, but provision is now made for operating it in conjunction with A.C. or D.C. high-tension supply units which may be mounted inside the cabinet. A revised model for frame aerial operation has been introduced; a special cabinet, with a frame built into its lid, is supplied, and more complete screening for the H.F. valve plate circuit components is provided. A short-wave kit set is another new production, for which a series of special coils, a choke and short-wave tuning condenser have been designed. The set, which covers all wavelengths between 10 and 200 metres, comprises a reacting detector followed by two L.F. stages.

The new Lotus kit sets, supplied in forms suitable for both battery and A.C. mains feed, have several interesting features. Both models are similar and embody the conventional circuit: they are assembled on a metal chassis with transverse and lateral screens on which many of the principal components are mounted in the factory before the kits are dispatched.



A Lissen short-wave coil.



Interior view of the Lotus kit set (battery model) showing arrangement of semi-ganged tuning condensers.

Dual-range coils with built-in switches are employed: these switches are "ganged," and are operated through a knob projecting

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The New Kit Sets.—

through the side of the cabinet. It is observed that decoupling is provided. There is space for batteries or mains unit on the base-board at the back of the cabinet, behind the lateral screen.

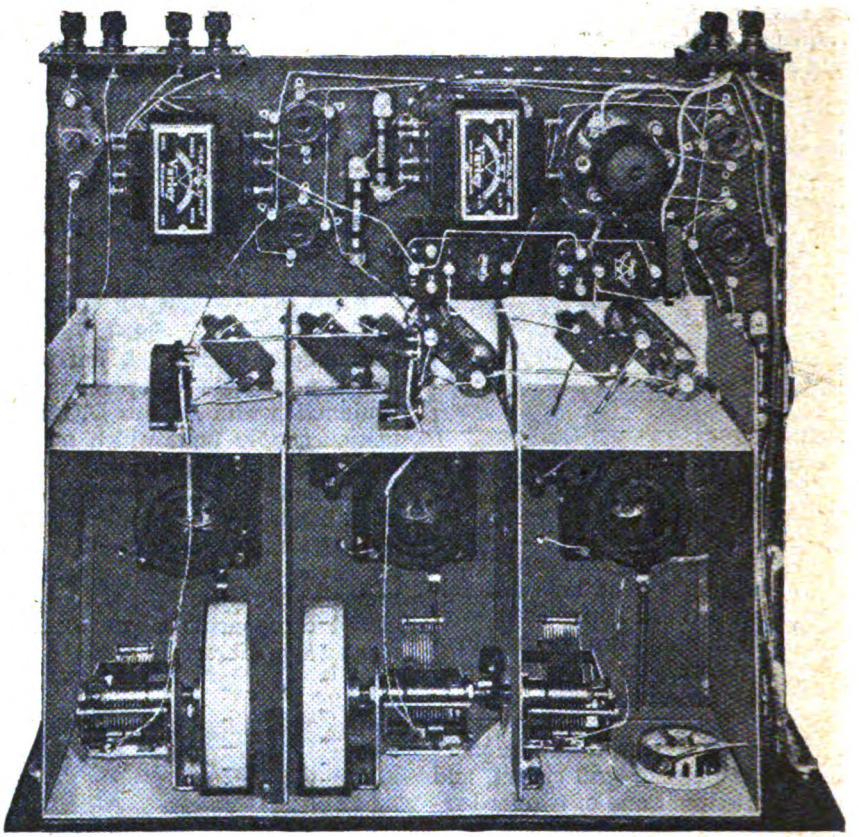
Volume control, in the case of the battery set, is effected through a rheostat in the H.F. valve filament circuit, while in the A.C. set a potentiometer feed for the screening grid serves a similar purpose. Indirectly heated valves are used in the latter receiver.

In both models provision is made for using a gramophone pick-up and the edgewise condenser dials are mounted side by side so that they can readily be rotated together, thus providing simultaneous tuning of the two circuits over parts of the scale.

An Entirely New Range.

Mullard kit sets for this season are entirely new. The first is the "Orgola Three," with a tuned grid H.F. amplifier and grid detector with reaction, followed by a pentode with transformer coupling. The two tuning condensers are ganged, with a "trimmer" across the aerial-grid coil; it is noted that lucid and helpful instructions are given regarding the proper use of this adjustment.

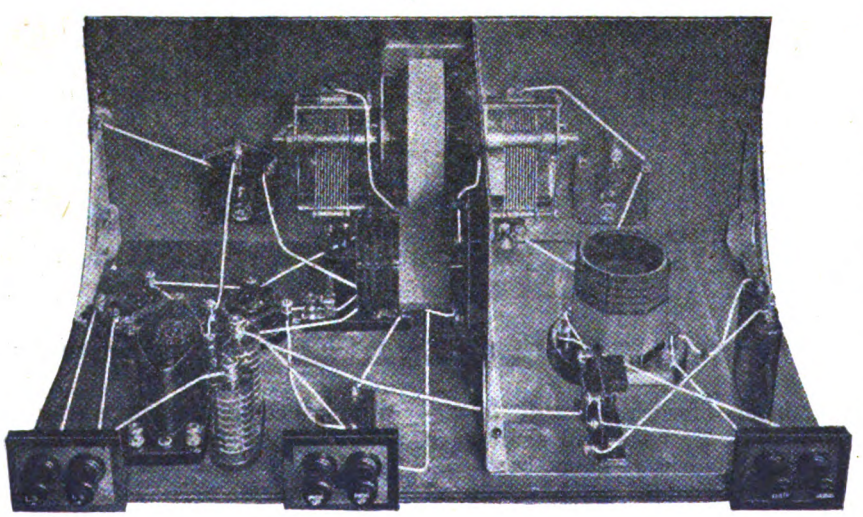
Reaction control is on the differential system, and, as provision is made for altering the inductive relation of the feed-back coil with respect to the grid winding, it should be possible so to arrange matters that regeneration is particularly well under control. Continuously variable aerial coupling, adjustable within wide limits, is also provided.



Plan view of the Mullard "Orgola Senior"; a six-valve receiver with two H.F. stages and push-pull output.

The design provides for connection of a pick-up in the detector grid circuit, and a switch is connected so that it may be put into operation in the easiest possible manner.

All the above applies also to the A.C. model, which uses indirectly heated valves. In addition, it has a bias cell for the H.F. valve, and the usual alteration is made to the low-tension circuit. This set is provided with H.T. current by a Mullard eliminator, and a special low-voltage transformer is supplied for feeding the valve heaters.



Rear view of the Mullard "Orgola" three-valve set. The detector grid coil is mounted on the vertical screen.

An Ambitious Product.

A six-valve kit set—the "Orgola Senior"—has also been evolved by the Mullard firm; there is little doubt that this is the most ambitious receiver yet produced in "kit" form. It embodies two H.F. stages, anode bend detector, and two L.F. amplifiers with push-pull output. The high-frequency valves are coupled by the

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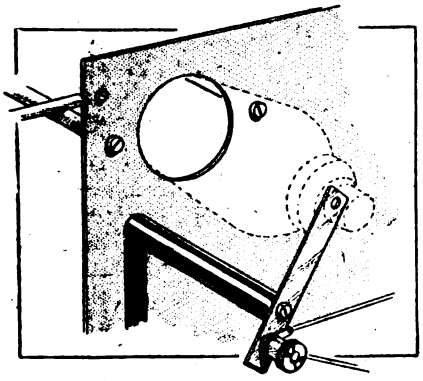
The New Kit Sets.—

parallel-feed method and their condensers are ganged; as there is a separate condenser for the aerial-grid circuit, the total number of tuning controls is reduced to two, and there is no reaction. Decoupling is provided in the anode circuits of detector and first-stage L.F. amplifier.



Details of the rigid H.F. valve anode connector in the "Music Magnet."

Volume control is effected by dimming the H.F. valve filaments, and there is also a variable condenser feed for the aerial coupling in order that overall selectivity may be under control. Screening is, of necessity, somewhat elaborate, and it is observed that the valves are so mounted that they are unaffected by the field of the inductance coils. Precautions are taken to prevent the application of H.F. voltages to the L.F. amplifier, and stabilising resistances of 100,000 ohms are inserted in series with the output valve grids. Wave-range switches are included in the coils, and a gramophone pick-up is connected in the same way as in the case of the three-valve set.

Both the "Orgola" and the "Orgola Senior" receivers may be fitted into a gramophone cabinet complete with turntable, pick-up, and built-in loud speaker; full instructions for thus converting the receivers into radio-gramophones are issued.

A Well-designed "Music Magnet."

At the first glance one is apt to form the impression that the new Osram "Music Magnet," already known to readers of our "Kit Constructors' Notes" section, has not been altered to any great extent, but a more careful examination shows that attention has been devoted to almost every detail of its design. The arrangement of the filament switch has been modified: this, taken in conjunction with the provision of an H.T. fuse, should render the set completely immune from risk of filament burn-outs. The drive mechanism of the gang condenser has been redesigned, and the coils have been altered considerably, with the result that H.F. losses have been reduced.

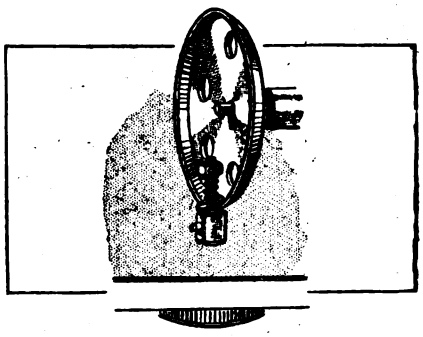
Wavelength Calibration.

Perhaps the most important modification is the provision of a condenser scale calibrated directly in wavelengths—as far as is known, this is the only kit set with this refinement.

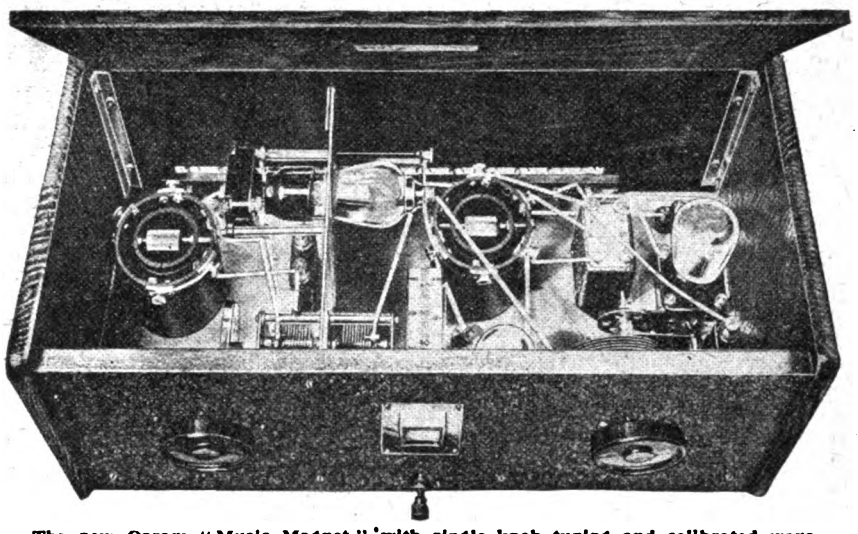
Other modifications include a new L.F. transformer with high-permeability core, and an improved form of grid condenser and leak assembly:

"THE 1930 EVERYMAN FOUR" will be described fully in next week's issue.

altogether, a most interesting set. It is now supplied complete with an oak cabinet in sections ready for assembly by the constructor.



The friction-driven crown wheel through which the double condenser of the "Music Magnet" is operated.



The new Osram "Music Magnet," with single knob tuning and calibrated wavelength scale.

The requirements of the home constructor living near a high-power station are catered for in an interesting and unconventional manner by the Varley Regional R.D.3 receiver, for which special components and an instructional leaflet are supplied. There is little risk in hazarding a guess that this set is the forerunner of a type that is bound to be popular in the near future. It embodies a detector with two low-frequency stages—clearly here is its principal feature of interest. The tuned aerial coil is coupled by means of a variable condenser to a tuned filter circuit. This set should have at least as good selectivity as the average receiver with a stage of H.F. amplification.

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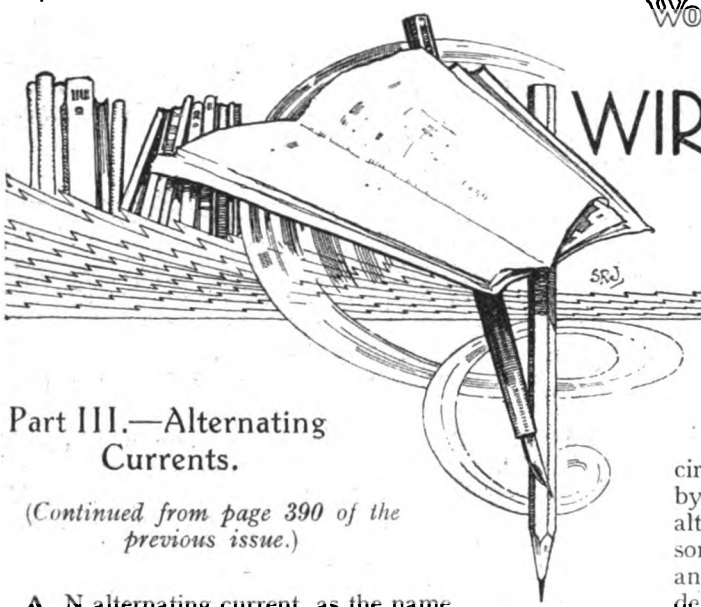

WIRELESS THEORY SIMPLIFIED

By S. O PEARSON, B.Sc., A.M.I.E.E.

Part III.—Alternating Currents.

(*Continued from page 390 of the previous issue.*)

AN alternating current, as the name implies, is one which flows first in one direction and then in the opposite direction alternately round a circuit, the reversal taking place at regular intervals. It will be remembered that a direct current was represented by a continuous stream of electrons moving in one direction round and round a closed circuit, being driven by a constant electromotive force. In the case of an alternating current the electrons representing it are rushing backwards and forwards round the circuit, and therefore the electromotive force driving them must also be periodically reversing or alternating.

A direct current was likened to a continuous stream of water flowing through a hose pipe connected to a tap which supplied the necessary driving pressure, and we can extend this analogy to meet the case of an alternating current. Imagine the hose pipe removed from the tap and then having its two ends connected to the opposite ends of a cylinder in which a double-acting piston moves backwards and forwards. Such an arrangement is shown in Fig. 1. The whole thing—hose pipe and cylinder—are assumed to be full of water without any air bubbles. As the piston moves from left to right it forces water out of the right-hand end of the cylinder, through the pipe and back into the left-hand end. When the piston comes to the end of the stroke all the water comes to rest, and then, when the piston begins to move from right to left, the flow of water in the pipe reverses. In this arrangement we have an alternating current of water.

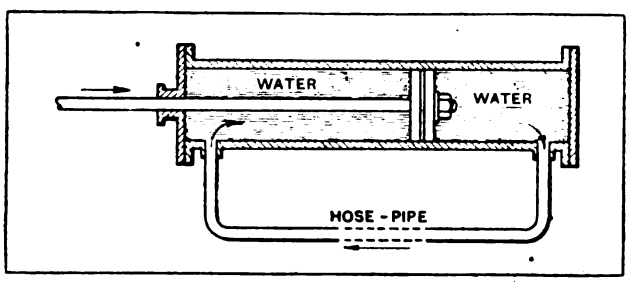

Fig. 1.—Cylinder pump and pipe arrangement illustrating the action of a closed alternating current circuit.

Now an alternating current of electricity (A.C.) follows very similar laws. There is a driving or electromotive force which keeps on reversing and so forcing the electrons backwards and forwards round a closed electric circuit. The alternating electromotive force is set up by some sort of generator, or by a microphone. An alternating current generator may be looked upon as a sort of electron pump which forces electrons backwards and forwards round an external circuit just as the cylinder pump forces the water backwards and forwards through the hose pipe.

Frequency.

It is necessary to know several things about an alternating current in order to define it fully or make any calculations relating to it. For instance, it is necessary to know how many times the current reverses its direction every second and how it varies from instant to instant. It is usual to consider the current as positive when flowing one way round the circuit and negative the other way round. It is quite immaterial which direction we choose as positive provided that, once having made our choice, we adhere to it.

The variation of the current from the time it starts from zero and passes through one complete sequence of positive and negative values back again to zero, is referred to as *one cycle*, and the time of one cycle in seconds or fractions of a second is called a period. The *frequency* or *periodicity* is the number of cycles passed through in one second, and thus the frequency is expressed in cycles per second. The standard commercial frequency of A.C. supply systems in this country is 50 cycles per second. Audible sounds are represented by a whole range of frequencies from about 25 cycles per second to 10,000 cycles per second or more according to the individual. Radio frequencies range from about 20,000 cycles per second up to several millions—a wavelength of 300 metres corresponds to a frequency of 1,000,000 cycles per second or 1,000 kilocycles per second, the wavelength being inversely proportional to the frequency.

An alternating current may vary from instant to instant according to any law or without any apparent law, but it is usual for the time of one complete sequence

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Wireless Theory Simplified.—

of positive values to be equal to the time of a complete sequence of negative values. These two sequences are called the positive half cycle and negative half cycle respectively. These names also apply to alternating electromotive forces and magnetic fluxes.

Sine Wave of Alternating Current.

If a graph is plotted showing the variation of current with time, the curve takes the form of a wave which may be any shape but is periodic—that is, it keeps on repeating itself as time progresses. Such a wave is shown in Fig. 2.

The simplest alternating current to deal with both in practice and in theory is one which gives a sine wave when all the successive values are plotted as a

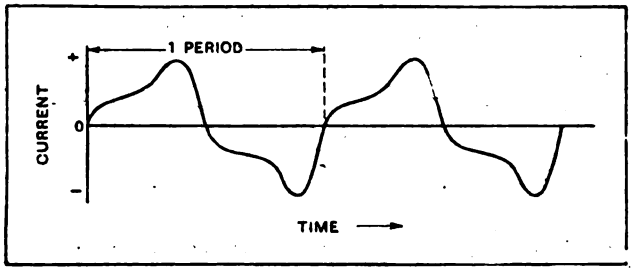

Fig. 2.—Showing how an alternating current can be represented as a graph.

graph to a time base, and this law is always assumed when working out alternating current problems unless otherwise stated. A sine wave of current is shown in Fig. 3.

The Effective Value of an Alternating Current.

The first thing we notice about the curve is that it is symmetrically placed about the base or zero line—that is to say, the positive half waves are exactly balanced by the negative half waves, and therefore the average value of the current taken over any whole number of cycles is equal to zero. It is clear then that to express the value of an alternating current in amperes we must adopt some means of comparing it with a direct current as regards its useful effects. For instance, either an alternating current or a direct current will produce heat if passed through a resistance wire, and it is on this basis that the strength of an alternating current in amperes is defined. The useful or *effective value*, as it is called, is defined as the value in amperes of *the steady direct current which would have the same average heating effect in a given fixed resistance*. This means that an alternating current whose effective value is 1 ampere will liberate heat in a given resistance at the same average rate as a direct current of 1 ampere in an equal resistance, i.e., the power in each would be the same. It is necessary to say *the same average rate* because the heat is given to the resistance by the alternating current in little pulses, the power falling to zero every half cycle as the current passes through its zero values.

If we know the shape of the alternating current wave it is an easy matter to determine its effective value. Assume any wave shape for the present, and let i be the value of the current at any one instant. Then in a resistance of R ohms the power at that instant will be i^2R watts (see Part II, last issue). Let I be the effective value or the value of the direct current which has the same average heating effect. Then from the definition above—

I^2R = mean value of i^2R over a whole cycle.

I^2R = (mean value of i^2) × R

or I^2 = (mean value of i^2);

and taking the square root of each side, the effective value is—

$$I = \sqrt{\text{mean value of } i^2} \text{ amperes.}$$

Putting this result into words: the effective value of an alternating current is equal to the root of the mean value of the squares of all the successive instantaneous values, and is often abbreviated to ROOT MEAN SQUARE value or R.M.S. value. *Virtual value* is another name frequently employed.

Effective Value of a Sine Wave.

Referring again to the sine curve of Fig. 3, it will be noticed that the current starts from zero and builds up to a maximum positive value which we have denoted by I_m in the figure, then falls to zero again, and once more builds up to the maximum value I_m, but this time in the reverse direction, being now negative. This maximum value I_m is called the amplitude of the current.

But the amplitude is not the useful or effective value of the current, and it behoves us to find what relationship exists between the effective value and the maximum value. To do this consider a sine wave of current which builds up to a maximum value of 1 ampere in each direction. Such a wave has been drawn to a suitable scale in Fig. 4, and is shown by curve (1). If we now divide the base line up into, say, 20 equal parts and measure the vertical distance from the centre of each part to the curve itself, we get the values of the current corresponding to the various instants de-

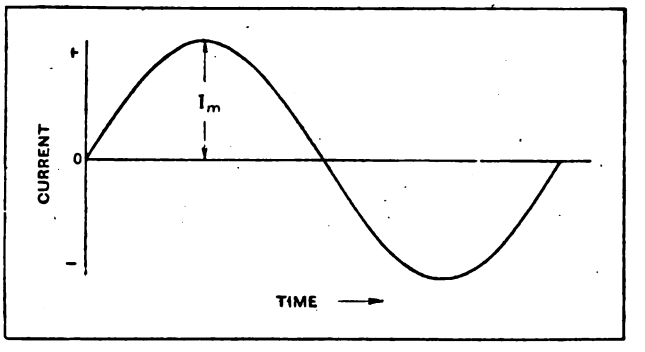

Fig. 3.—Simple sine wave of current.

picted by the centres of the 20 equal intervals. We require the *root mean square* value of the current, and so the next thing to do is to square each of the current values so obtained, i.e., multiply each value by itself and plot the figures thus found as a new curve to the same base line. If the sine curve (1) is accurately

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Wireless Theory Simplified.—

drawn, it will be found that the new current squared curve (2) shown shaded will be another sine wave of half the wavelength or double the frequency. Note that even over the negative half cycle the current squared is still a positive quantity, because when two negative quantities are multiplied together the product is positive—the old saying that "two negatives make a positive," etc.

It will be seen that the new curve (2) is not symmetrically placed about the base line, as is the case for the current curve. In fact, the new curve is so disposed that at its lowest points it only just touches the base line, so that *its* centre line falls at a height above the base line *just equal to half the maximum height.*

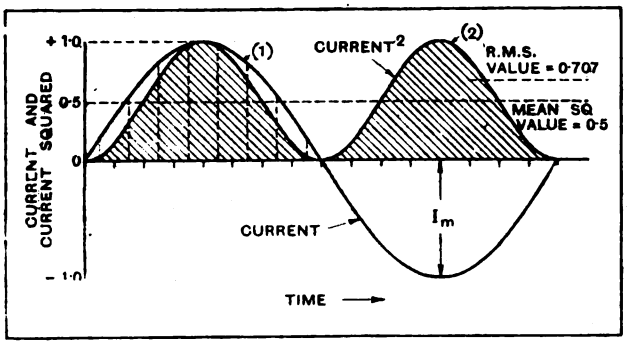

Fig. 4.—Diagram for showing that the R.M.S. value of a sine wave is 0.707 of the maximum value.

Therefore, the *mean square* value is equal to $\frac{1}{2}$ in this case where the maximum value of the current is 1 ampere.

Thus if the maximum value of the current is I_m amperes, the *mean square* value will be $\frac{1}{2}I_m^2$, and the *root mean square* (R.M.S.) value is the square root of this, namely:—

$$\text{R.M.S. value} \qquad I = \sqrt{\tfrac{1}{2}I_m^2} = \frac{I_m}{\sqrt{2}}$$

$$\text{or} \qquad I = 0.707\ I_m$$

This is a very important result—it means that for a sine wave the effective value is 0.707 of the maximum value of amplitude, or, conversely, the maximum or peak value is $\sqrt{2}$ times or 1.414 times the effective value. The same rules apply to alternating electromotive forces and potential differences.

Alternating current ammeters and voltmeters are always calibrated to read directly in effective or R.M.S. values.

The relationship between the effective value and maximum value for a sine wave has been arrived at by graphical means without the use of mathematics; but even so there may be some who will at first find a little difficulty in following the reasoning. This need not cause any misgiving, as the work to follow will be based, not on the particular reasoning referred to, but on the result, namely, that the ratio of the effective value to maximum value for a sine wave is 0.707.

(To be continued.)

CURRENT TOPICS.

PERILS OF THE PORTABLE.

A portable owner who switched on his set in a Birmingham street has been fined 10s. for drawing a crowd which caused obstruction.

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"Q" CALL WITH A KICK IN IT.

Among a collection of new Morse abbreviations suggested by the amateur transmitters of America is the following:

QLF: Say, OM, send with your LEFT foot now.

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SUN SPOTS MISFIRE.

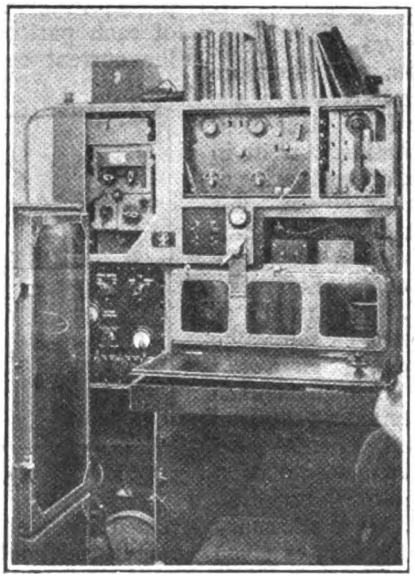
Despite the recent prediction of Professor Stetson, astronomer at Harvard University, that the present month would be a bad one for wireless reception owing to sunspots, listeners are failing to note any reduction in signal strength. It seems that a sunspot means nothing to Brookman's Park.

o o o o

LISTENER'S LICENCE CANCELLED.

To Mr. A. Britton, of Fishponds, Bristol, apparently belongs the unenviable distinction of being the first listener to have his licence suspended by the Post Office for having caused interference by oscillation.

It is well known, of course, that the Post Office reserves the right to take action of this kind, a statement to this effect being printed on each licence issued; but the interesting point now arises whether the offender is doomed never again to hear a B.B.C. programme on his own receiver or whether a limit is set to the period of penance. A statement regarding the P.M.G.'s powers in this direction would be welcome.



WIRELESS WITHOUT WEIGHT. The radio cabin on the R. 101, Britain's new airship, which is undergoing preliminary trials this week. Note the aluminium case containing the apparatus.

o o o o

B.B.C. ESCAPES CRITICISM.

The recent drought is said to have been exceptional in that no one attributed it to wireless.

o o o o

NEW B.B.C. OUTPOST.

The B.B.C.'s new receiving station at Tatsfield, Surrey, is now in use and the apparatus at Keston is being dismantled.

o o o o

AMATEURS UNITE AT MANCHESTER.

In connection with the Manchester Wireless Exhibition, which opens at the City Hall on Wednesday next, October 16th, the Association of British Radio Societies is organising a National Radio Convention. The plans include several social functions, discussions on amateur topics, and visits to the Exhibition and other places of interest in the Manchester area.

The Convention will be open to members of any radio society. Those wishing to attend are invited to apply for particulars to Mr L. A. Gill, Secretary of the Association, Hope House, South Reddish, Stockport.

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LECTURE BY DR. N. W. McLACHLAN.

Under the auspices of the Association of British Radio Societies, Dr. N. W. McLachlan, M.I.E.E., F.Inst.P., will lecture on "The Ideal Loud Speaker" at a

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meeting in the Albert Hall, Peter Street, Manchester, on Monday, October 28th, at 7.30 p.m. The lecture will be followed by demonstrations in tone compensation and control for electric gramophones.

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POST OFFICE AND SICK "PIRATES."

In a letter to an enquirer, the Post Office states that during the past four years 3,230 prosecutions have been undertaken against infringers of the Wireless Telegraphy Acts. In taking legal proceedings, adds the Post Office, full consideration was given to the circumstances of each case, including the age of the offender and any special factor such as his ill-health.

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BRITISH COASTAL WIRELESS: A DANE SPEAKS OUT.

Captain G. Mikkelsen, a Danish navigator, has made a statement deploring the lack of wireless facilities in North Britain, writes a correspondent. "Along the coasts of Norway, Sweden, Denmark and the Faroe Islands," says the captain, "there are wireless stations to aid navigators, but when proceeding round the north coast of Scotland and the Orkney and Shetland Isles, valuable time is lost. In foggy weather the navigator must take his observations from the sun or rely on the chart before taking the dangerous passages on this coast."

It is possible that the worthy captain has overlooked the existence of the beacon station at Wick, which is extensively used by ships skirting the northern coast of Scotland.

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CALIBRATION SIGNALS FROM GERMANY.

In view of the increasing congestion of the ether and the consequent necessity that transmitting stations should not depart from their allotted wavelengths, it is essential that means should exist for their exact calibration.

For some time past the German high-power transmitter at Koenigswusterhausen has broadcast at regular periods calibrated waves for the benefit of Europe in general, and of its own country in particular. These special transmissions take place on the 14th and 15th day of each month, according to the following schedule :—

Time.	Kc.	Metres.	Signal.
	First Day.		
06.00-06.05	345	870	A
06.15-06.20	333	900	O
06.30-06.35	323	930	G
06.45-06.50	257.5	1164	J
07.00-07.05	256	1170	K
07.15-07.20	250	1200	O
07.30-07.35	248	1210	P
07.45-07.50	243	1235	X
08.00-08.05	238	1260	Y
08.15-08.20	207.5	1444	Z
	Second Day.		
06.00-06.05	538	557	A
06.15-06.20	429	700	O
06.30-06.35	353	849	G
06.45-06.50	284	1055	J
07.00-07.05	276.5	1084	K
07.15-07.20	273.5	1097	O
07.30-07.35	267	1124	P
07.45-07.50	260.5	1152	X
08.00-08.05	233	1288	Y
08.15-08.20	217.5	1380	Z
08.30-08.45	224	1340	Q

At the beginning of each transmission a short tuning signal is sent out, and is followed by the call-sign in Morse, as given in the fourth column. In the event of any unforeseen interruption taking place, in order that the time schedule should not be completely upset, the "missing" signals are specially broadcast at the end of the transmission and an announcement made to that effect.

Again, should the 14th or 15th day of the month coincide with a Sunday or holiday, the transmission of the calibrated signals is postponed until the following day.

As these signals are accurately measured, the broadcasts are regularly used by both German telegraphy and telephony transmitters to check their wavelengths, and should also prove of use to amateurs for the calibration of medium- and long-wave wireless receivers.

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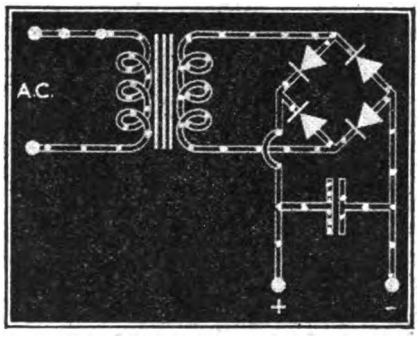
ANIMATED WIRELESS DIAGRAMS.

Secretaries of radio societies will be interested in a clever film, entitled "Rectification," which has been produced by the Westinghouse Brake and Saxby Signal Co., Ltd., to demonstrate the action of electric currents in circuits employing the



ANIMATED CIRCUITS. A "still" taken from the film "Rectification," showing how the current flows in the "bridge" method of obtaining full-wave rectification.

Westinghouse metal rectifier. It is expected that this film will be included in the series of lectures which will be given by the Westinghouse Company to a selected number of radio societies.

Much more clearly than the simplest book of words, the film shows the difference between alternating, direct, half-wave and full-wave rectified currents. Working circuits are shown of half-wave rectification using the Westinghouse H.T.3 rectifier, full-wave rectification with the H.T.1 type, and voltage doubling rectification with the H.T.4 type.

The moving diagrams, of which a specimen is shown herewith, were drawn in the same manner as "cartoon" films, forty separate pictures being necessary for a complete cycle of operations.

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TRIPLE RADIO FUSION IN U.S.

Over 700 American wireless patents have come under a single control as the result of the merger between the three radio concerns, Kolster, Earl and Freed-Eisemann. The new organisation is the second largest of its kind in the United States, the Radio Corporation of America coming first.

THE INVENTOR'S FRIEND.

Inventive minds will find much to interest and encourage in *The Inventor*, the official journal of the Institute of Patentees, which makes its first appearance this month. The journal sets out "to promote the burgeoning of new ideas."

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U.S. TO AUSTRALIA *VIA* BRITAIN.

The British Post Office switched Australia through to America by wireless telephone on September 25th when the new short-wave radio telephone service between England and Australia was linked up with the Atlantic telephone service.

Speech from New York passed over land wires to the short-wave transmitting centre of the American Telephone and Telegraph Company in Lawrenceville, New Jersey, thence by radio to the short-wave receiving station of the British Post Office at Baldock, Herts, and thence by wire *via* London to the Post Office transmitting station at Rugby. From there a direct radio link carried the speech to the receiving station of Amalgamated Wireless of Australia and by wire to Sydney. The path of speech from Australia was again to Baldock, thence through London to Rugby and onward *via* the American Company's short-wave receiving station at Netcong, New Jersey, to New York.

Conversation was carried on successfully over a distance of 15,000 miles. It is probable that the England-Australia telephone service will soon be open for commercial use.

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PREMIER'S U.S. SPEECH ON SHORT WAVES.

As stated in *The Wireless World* in July last, the American National Broadcasting Company's short-wave stations will be used to relay the speeches of the Prime Minister during his visit to the United States.

On Friday next, October 11th, Mr. MacDonald's speech at a dinner to be given in his honour by the Council of Foreign Relations at the Ritz-Carlton Hotel, New York, will be relayed all over America. We understand that the transmission will also go out from 2XAD, Schenectady (19.56 metres), 2XAF, Schenectady (31.48 metres) and 8XK, Pittsburgh (35.25 metres). The speech will begin at 9 p.m. (2 a.m. G.M.T.).

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A "B.B.C." FOR CANADA.

A chain of high-power broadcasting stations across Canada is recommended in the report of the Royal Commission recently appointed to investigate Canada's wireless problems. It is also recommended that a State-owned corporation should be set up, similar to the B.B.C., and that funds necessary for the operation and maintenance of the service should be obtained from licence fees and programmes sponsored by advertisers, together with a Federal Government subsidy of $1,000,000 annually for five years.

As a nucleus of the broadcasting chain, it is suggested that seven 50-kilowatt stations should be erected to give reliable service over the populated areas of the Dominion.

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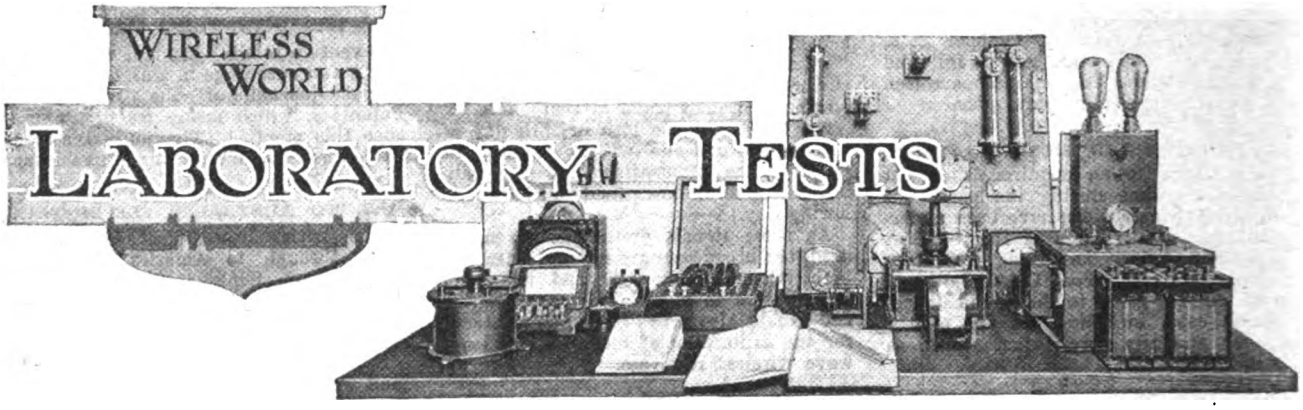


A Review of the Latest Products of the Manufacturers.

MODIFICATIONS TO STANDARD WET BATTERIES.

Readers will be familiar with these batteries since we have published test reports from time to time on various sizes. The latest improvements take the form of attention to details, the fundamental principle being the same as discussed in our reviews. To facilitate the initial assembly, and also ease the replacement process, the zincs and sacs are now supplied in the form of a cartridge which drops into the glass container. These are made for Nos. 3 and 4 size jars A further improvement is the provision of a cork stopper, with a centre hole to clear the carbon rod. This is to prevent evaporation and, incidentally, creeping of the electrolyte, and replaces the earlier method of covering the top of the fluid with oil. It is a far better seal and results in a more workmanlike finish than was possible with the earlier models.

The cartridge, complete with cork, for the No. 3 size jar, costs 5d. each, and for the No. 4 size the price is 7d. Spare jars cost 2d. for No. 3 size and 2½d. for the No. 4 size. It is not essential to purchase new jars as the cartridges can be used with the ordinary No. 3 and No. 4 size containers.

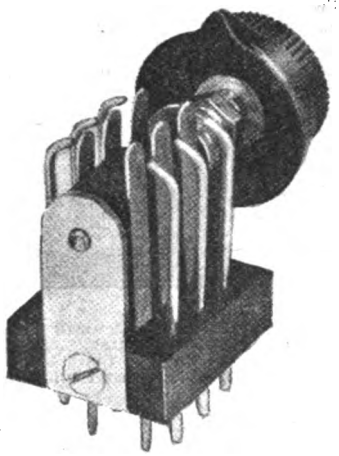
The makers are the Standard Wet Battery Co., 184-188, Shaftesbury Avenue, London, W.C.2.

New cartridge-type zinc and sac for Standard Wet H.T. batteries.

°°°°

DETEX SWITCHES.

Since the advent of the screened valve the switching from medium to long waves has become a fairly simple matter, and many new multi-contact components have been developed. Where space behind the panel is limited, the Detex change-over switch should be found a useful asset, as this component takes up very little panel space. A single-hole fixing bush is fitted.



A feature of this Detex switch is the provision of a delayed action contact for filament or H.T. control.

The body of the component consists of a machined ebonite block, and this supports the contacts and bearings for the operating spindle. A point of particular interest is the provision of one contact having a slight lag behind the others. This is so arranged to be the last contact to "make" and the first to "break."

The wiring of a receiver can be arranged so that the H.T. circuit is always the last to be completed and the first to be broken when switching off. This feature assures that the H.T. blocking condensers will not be left in a charged state.

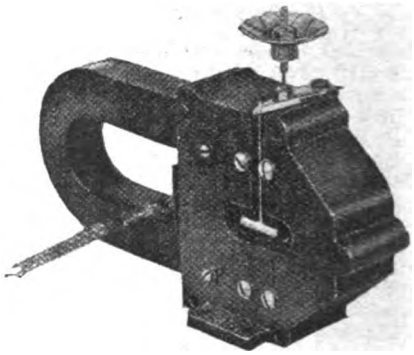
These change-over switches are made by Detex Distributors, Ltd., 66, Victoria Street, London, S.W.1, and prices have been fixed as follows: Two-pole, 3s. 6d.: 3-pole, 3s. 9d.; 4-pole, 4s.; 5-pole, 4s. 3d. and 6-pole, 4s. 6d.

°°°°

"ISOMONA" LOUD SPEAKER UNIT.

This is a balanced armature movement for incorporating in cone-type loud speakers and consists of a massive permanent magnet fitted with two laminated pole-pieces shaped to concentrate the flux at each end of the armature. This is disposed centrally in the air gaps and fixed at its centre. The polarising coils, of which there are two, are disposed either side of the fulcrum with the armature passing through their centres.

The spindle, carrying the cone, is attached to the centre of a short stiff reed, one end of which is rigidly fixed while the free end is connected by a thin rod to one extremity of the vibrating armature.



"Isomona" cone loud speaker unit; a balanced armature movement.

The pole-pieces, coils and armature are encased in a black crystalline-finished aluminium cover built up from two castings clamped together. A lug on each casting is provided for fixing purposes, four screws being supplied.

These units are supplied by Messrs. Haw and Co., 20, Cheapside, London, E.C.2, and the price is 21s.

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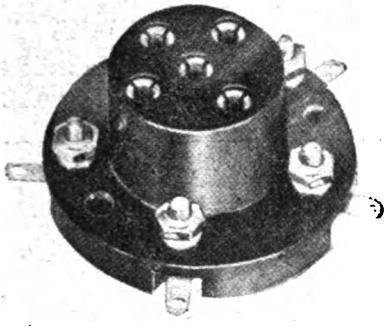
WEARITE 5-PIN VALVE HOLDER.

This valve holder is fitted with five sockets, four being disposed as usual, and the fifth situated centrally with respect to these. It has been placed on the market by Messrs. Wright and Weaire, Ltd., 740, High Road, Tottenham, London, N.17, to meet the requirements of the new 5-pin A.C. valves, but it can be used also with the ordinary 4-pin type, thereby facilitating easy change of valves for experimental purposes.

The body is made from moulded material, and the sockets are split to ensure a good electrical contact with the pins on the valve. Soldering tags, in addition to terminals, are provided, these being fixed by small screws to the base of the sockets.



Wearite 5-pin A.C. valve holder.

The terminals are clearly marked by appropriate letters moulded into the material, and two screw holes are provided for fixing purposes. The price is 1s. 3d.

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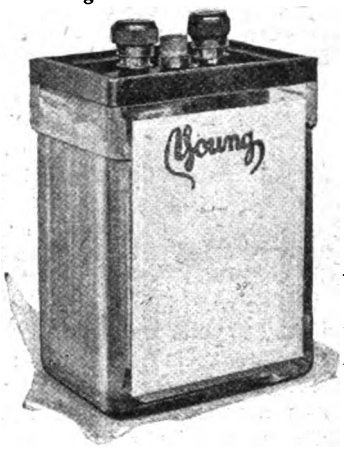
YOUNG'S "DRI-POWER" ACCUMULATORS.

These accumulators, which are available in various types, including car-starter batteries and cells for wireless purposes, have their plates embedded in a gelatinous substance saturated with acid. Since there is no loose liquid they are unspillable, and the smaller sizes are particularly suitable for use in portable sets. Generally the employment of a solid electrolyte leads to a loss in ampere-hour capacity for any given size of battery, but the makers of the "Dri-power" cells claim that this disadvantage has been satisfactorily overcome.

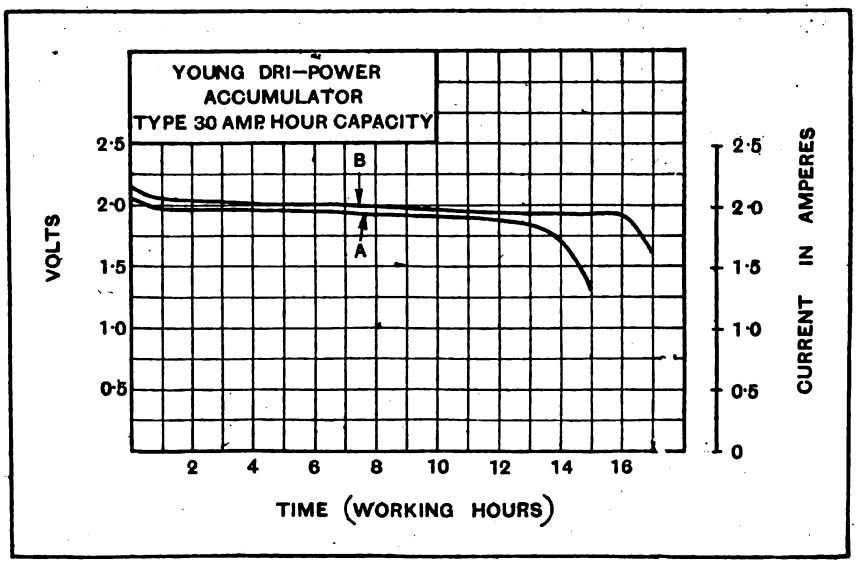
Furthermore it is claimed that a special process of manufacture enables the cells to be roughly handled, in the electrical sense, without seriously impairing the life of the battery. To test this statement we subjected a sample 2-volt cell to a period of heavy discharges and charging at a higher rate than normal.

Subsequently a discharge curve was taken of the cell after a normal charge, the rate of discharge being approximately 2 amps. at the start. The voltage was maintained at a good level during this test, and it was found that the ampere-hour capacity returned to normal after a short period of normal charge and discharge. Since an accumulator can often be seriously damaged by the treatment it receives when first put into use, this test would appear to confirm the makers' claim that these cells are very robust and will not deteriorate if subjected to periods of rough handling.



Young "Dri-power" 2-volt L.T. accumulator with solid electrolyte.

Two-volt cells in glass containers and filled with "Dri-power" solid electrolyte are available in 20-, 30- and 40-ampere-hour sizes, the prices being 14s. 6d., 16s. 6d. and 18s. 6d. respectively. These are supplied fully charged. High tension units of 24 volts each in glass containers and with solid electrolyte are available also at £1 10s. each. These have a milli-ampere-hour capacity of 7,500 at a discharge rate of 15 mA or 5,000 mA-hour capacity at 50 mA discharge.



Discharge curve of Young "Dri-power" accumulator. Curve "A" taken after a period of over-charge and discharge. Curve "B" shows normal life on one charge after a period of normal treatment and recuperation.

The makers are the Young Accumulator Company (1929), Ltd., Burlington Works, Rigault Road, Fulham, London, S.W.6.

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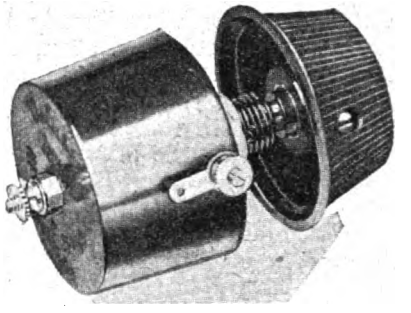
HARLIE VOLUSTAT.

These variable resistances, which are made in three ranges, namely, Universal type, 50 to 500,000 ohms; medium resistance type, 2,000 ohms to 2 megohms; and high resistance type, 10,000 ohms to 10 megohms, function on the compression principle. The ingredients and quality of the resistance material has been, it is claimed, the subject of much experiment since the constancy of these resistances depends on the use of a mixture which will not pack when compressed, but returns to its original volume when the pressure is released.

Practical tests show that the resistance can be set at any given value, and it will keep this value for a long period. We did not subject the sample to the passage of heavy currents, but to that which would pass normally when the component was used as a volume control. The measured maximum and minimum values of the sample tested were found to be 720,000 ohms and 43 ohms respectively. Nominally these are 500,000 and 50 ohms, this being the "Universal" model.



Harlie "Universal" type Volustat.

The makers are Messrs. Harlie Bros., Balham Road, Lower Edmonton, London, N.9, and the price of all three types is 7s. 6d each.

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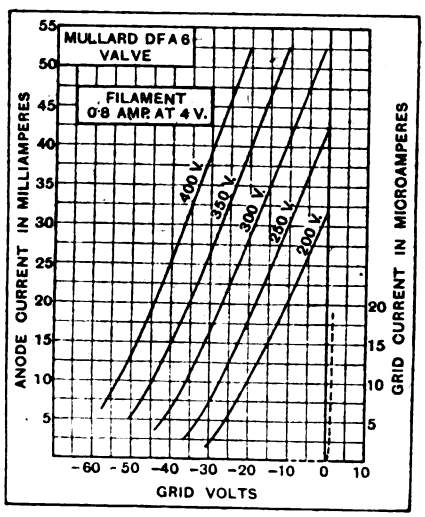
VALVES WE HAVE TESTED

Mullard D.F.A. Power-Amplifying Valves.

THE three valves dealt with under this heading are the D.F.A.6, D.F.A.7, and the D.F.A.8. Each requires 4.5 volts across the filament, and consumes 0.85 amp. of current. Since a 6-volt accumulator will normally be used, a fixed resistor of about 1.8 ohms, connected in the positive L.T. lead, will be necessary to absorb the excess voltage. The maximum plate potential is 400 volts in each case. The D.F.A.6 and D.F.A.7 are power output valves, the principal difference being in the grid swing that can be handled by each without causing grid current to flow.

D.F.A.6.

The particular function of the D.F.A.6 is an output valve in an amplifier designed to operate a moving-coil loud speaker. Its rated characteristics, measured at 100 volts H.T. and zero grid bias, are A.C. resistance 4,500 ohms, amplification factor 6.4, and mutual conductance 1.45 mA. per volt. The sample tested, however, did not show such a good mutual conductance under these conditions, the figures obtained being, A.C. resistance 5,900 ohms, amplification factor 5.7, and "slope" 0.97 mA. per volt.



Average values under normal working conditions; A.C. resistance, 4,630 ohms; amplification factor, 5.7; mutual conductance, 1.23 mA/volt.

Under working conditions, i.e., with 400 volts on the anode and minus 40 volts grid bias, an improvement in the efficiency of the valve was recorded the A.C. resistance dropped to 4,630 ohms; the amplification factor remained the same, but the mutual conductance improved to 1.23 mA. per volt. From the figures obtained it is possible to calculate the maximum undistorted power, in watts, that the valve may be expected to deliver to the loud speaker. This, of course, must be based on the relationship between the impedance of the speaker and the A.C. resistance (or impedance) of the valve. Assuming that the loud speaker impedance is equal to, or only slightly greater than, the A.C. resistance of the valve and that there are no other factors likely to modify the results, an undistorted output of approximately 1.4 watts should be available. This is sufficient to operate a good moving-coil loud speaker at something approaching full volume.

The following tabulated matter gives an indication of the anode current at various anode potentials and optimum grid bias, and will be a useful guide when choosing an output choke or transformer.

D.F.A. 6.

Anode Volts.	Grid Bias.	Anode Current.
200	- 18 volts	12.5 mA.
250	- 22 ,,	15.5 ,,
300	- 27 ,,	19 ,,
350	- 34 ,,	22.5 ,,
400	- 40 ,,	25 ,,

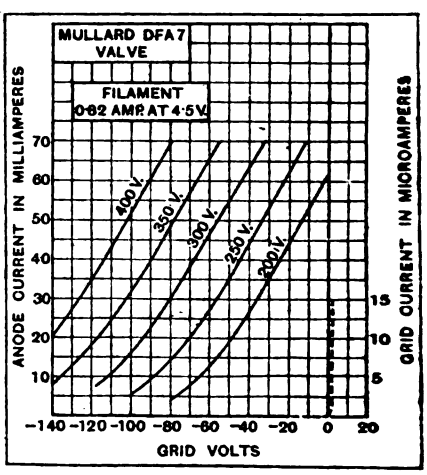
D.F.A.7.

Like the D.F.A.6, this is a terminal valve and should be employed in the output position when very big grid swings have to be accepted in the last stage. With the maximum plate potential a grid bias of the order of 120 volts should be used. Its measured characteristics at 100 volts H.T. and zero grid bias agreed very closely with those given by the makers. These values did not alter materially under working conditions, as will be seen from the following table.

D.F.A. 7.

Conditions.	A.C. Resistance, Ohms.	Amplification Factor.	Mutual Conductance.
Maker's rating 100 v. H.T. zero G.B. ..	2,850	2.4	0.85 mA/V.
Measured at 100 v. H.T., zero G.B. ..	2,860	2.3	0.80 mA/V.
Measured at 400 H.T. — 120 G.B. ..	2,570	2.2	0.85 mA/V.

Subject to the same conditions as mentioned with regard to the power output from the D.F.A.6, the maximum undistorted power given by the D.F.A.7 will be of the order of 3.4 watts.



Average values under normal working conditions; A.C. resistance, 2,570 ohms; amplification factor, 2.2; mutual conductance, 0.85 mA/volt.

D.F.A.8.

Although this is a power amplifying valve, in that it is designed to operate with a high anode potential, it does not come within the

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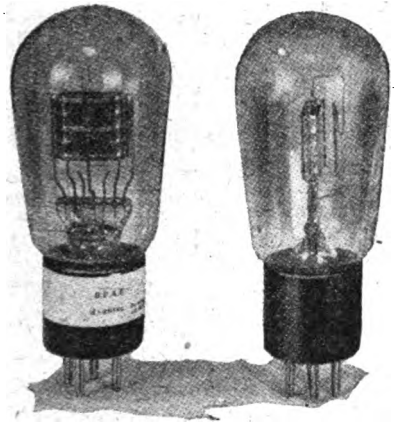
Valves we have Tested.—

category of super-power valves, since it will neither accept a very large grid swing nor deliver much power in terms of output watts. Its particular use is as a penultimate valve in an amplifier operating from a single H.T. source of the order of 400 volts. Its characteristics are given as 15,000 ohms



Typical examples of valves of the D.F.A. series.

A.C. resistance, 19.5 amplification factor, and 1.28 mA. per volt mutual conductance.

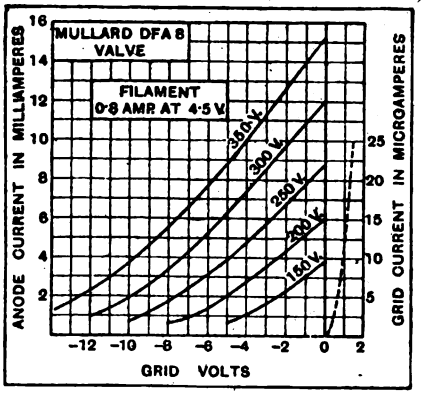
Measurements made with a specimen D.F.A.8 at 100 volts H.T. and zero grid bias gave the A.C. resistance of the particular sample tested as 28,000 ohms. The amplification factor was found to be 20, and the mutual conductance 0.7 mA. per volt. Tested under normal operating conditions with a high anode potential and suitable grid bias the average values were found to be: A.C. resistance 20,000 ohms, amplification factor 22.2, and mutual conductance 1.12 mA. per volt.

A resistance-capacity intervalve coupling would appear to be the most suitable arrangement to adopt, since power resistances capable of passing a current of the order of 5 to 10 mA. are readily obtainable. The following table shows the anode current at various grid potentials with different values of anode voltage.

D.F.A. 8.

Anode Volts.	Normal Grid Bias (Amplifier).	Anode Current in mA.
200	− 4½ volts	2.4
250	− 6	3.1
300	− 7½	3.8
350	− 9	4.5

The valves in this class are not "gettered," the required vacuum being obtained by pumping for a long period. Each specimen was tested for reverse grid current, but not the slightest trace was to be found. The inside of the glass



Average values under normal working conditions; A.C. resistance, 20,000 ohms; amplification factor, 22.2; mutual conductance, 1.12 mA/volt.

bulb is quite clear and the electrode assembly can be easily examined. Vertical "hairpin" filaments are used, the grid and anode being of the familiar "flattened" type.

A CONVENIENT EARTH FOR FLAT-DWELLERS.

Using the Metal Conduit for the Electric Light Wiring.

ACCORDING to the "Regulations for the Electrical Equipment of Buildings," published by the Institution of Electrical Engineers, and adopted as standard by all reputable contractors, the greatest resistance that is permissible between any part of the metal casing through which the wires are run, and earth, is two ohms. This regulation is intended to ensure that if through the failure of the insulation on some part of the wire within the casing, the casing itself becomes momentarily "live," the resulting current to earth shall be great enough to blow the protecting fuses immediately. There is thus no risk of shock to anyone who may touch the casing within the building, while earth leakage, which is one of the bugbears of the power-station engineer, is not permitted to persist.

Water-pipe Earth Not Always Satisfactory.

From the point of view of the user of wireless apparatus this careful earthing of the casing also has its merits. Few dwellers in flats can bury large copper plates in the garden for their earth connection, for if they have a garden at all it is usually paved. The usual alternative of a water-pipe is satisfactory enough, provided that the water-pipe chosen goes direct to earth, and not merely to a cistern, but it often involves leads that straggle untidily through several rooms and a landing. There is also the difficulty of making good connection to a water-pipe covered with several coats of paint.

Where electric light is installed it is naturally available in the room which contains the wireless receiver, so that only a comparatively short lead will be necessary if it is decided to earth the set to the casing. Connection may be made to the casing by removing one of the set-screws used at the joints between lengths of the tubing and getting the paint off it by soaking it for a few hours in an egg-cup full of turpentine. It can then be cleaned up with emery-paper and returned to its position, screwing down the earth-wire from the set under its head.

Freedom from Machinery Noises.

To judge from a limited experience of this method of earthing on a recently installed A.C. system, there are no disadvantages, from a purely wireless point of view, in its adoption; in particular, noises derived from rotating machinery and carried up to the set by the electric light wires do not appear to be accentuated appreciably. As for the D.C. resistance, a measurement between the casing and a water-pipe, both situated on the top floor of a three-storey building, showed it to be only a shade over half an ohm. It may therefore be regarded as a highly satisfactory earth.—A. L. M. S.

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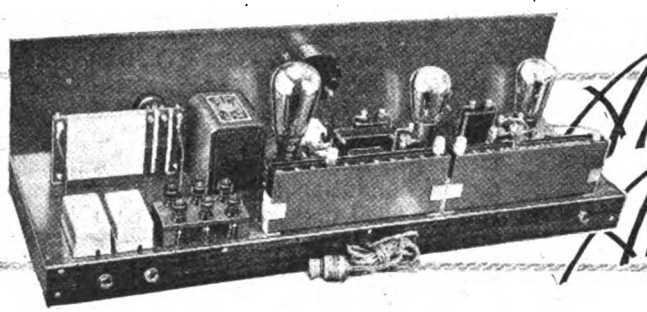
A.C. Eliminator for the All-Electric Amplifier



Design of Rectifying Equipment, including Field Excitation.

By A. P. CASTELLAIN, B.Sc., A.C.G.I., D.I.C.

ALTHOUGH the "All-electric Amplifier" recently described in this journal[1] was intended for operation from D.C. mains or from batteries, a prophetic instinct on the part of its designer led him to state that with fairly simple modifications the instrument might be run from A.C. mains with a suitable eliminator. Subsequent requests from a large number of readers have shown that there is a strong demand for an A.C. eliminator capable of giving satisfactory service with this amplifier, and the object of this article is to describe two circuits which can be thoroughly recommended.

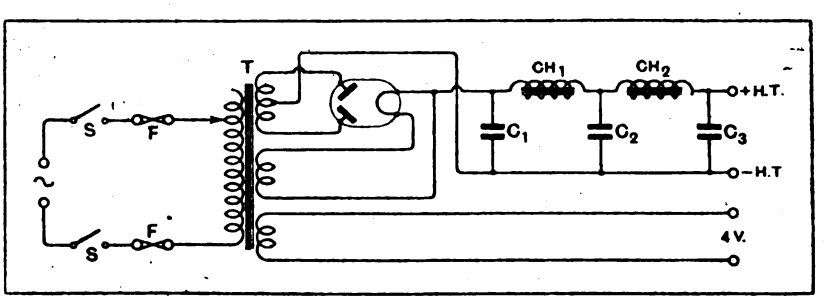


Fig. 1a.—Eliminator using a single full-wave rectifying valve.

For normal home use on A.C. supply an amplifier and eliminator using 200 volts H.T. with Mazda A.C. valves (which have indirectly heated cathodes) will give results as to volume and quality exactly equivalent to those obtainable with the all-electric amplifier as described for use on D.C. mains. In the amplifier the valves should be the AC/HL, AC/P, and AC/P1 in the first, second, and third stages respectively. For the eliminator there are two alternatives, depending on whether it is also required to supply the field current for a moving-coil speaker.

Where the amplifier alone has to be considered, the full wave rectifier UU60/250, capable of supplying 60 milliamps. D.C., will be sufficient, while if a 200-volt moving-coil speaker is to be used it will be necessary to use two single-wave rectifiers U.75/300, capable of giving a total D.C. output of 150 milliamps. Since the difference in cost between these two alternatives is so small, the two U.75/300s costing together 30s. as compared with 22s. 6d. for one UU60/250, it is really worth while catering for the greater output, which may come in useful at a later date. The circuits for the two arrangements are shown in Figs. 1a and 1b.

The transformer included in these circuits is the standard Met.-Vic. type AB with a separate 4-volt winding for feeding the heaters of the valves in the amplifier, in addition to the normal 4-volt winding for the rectifying valves. With the two single-wave rectifiers this eliminator will supply a loud speaker with a 20-watt 200-volt field besides feeding the amplifier.

For those readers who desire to use a higher H.T. voltage to obtain a greater power output, an eliminator incorporating a gas rectifier can thoroughly be recommended. Such a rectifier will supply up to 250 milliamps. at 400 volts.

Although it is quite possible to use valves of the L.S.5 class in the first stage of the amplifier, it will probably be found more convenient, in order to obtain an amplifier free from hum on A.C., again to use an indirectly heated cathode valve, such as the AC/HL, for the first stage. Fig. 2 shows the circuit of an eliminator designed with this object in view. The output valve may be an L.S.5a, an L.S.6a, or several of these in

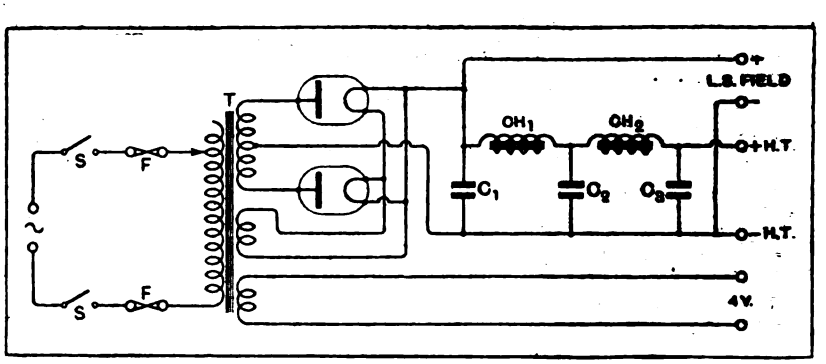


Fig. 1b.—An A.C. unit with two half-wave rectifying valves for feeding the loud speaker field as well as the valves in the amplifier. C_1 is 6 mfds., C_2 and C_3 2 mfds., 750 volt D.C. test. CH_1 and CH_2 are Ferranti B1 chokes. The condenser and choke values apply to Fig. 1a.

[1] June 19th and 26th, 1929.

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A.C. Eliminator for the All-Electric Amplifier.—

parallel. The mains transformer is not quite a standard article, but any good transformer manufacturer will be able to make it up at a cost of about £4 or £5.

The gas rectifier requires barretters (*i.e.*, series resistances in the form of spirals of iron wire enclosed in bulbs containing gas) in order to prevent arcing over, and as the filament is very thick and takes some time to come up to its final temperature, a separate switch should be used for connecting up the output to the amplifier. Thus the method of procedure in starting up is to apply the main switch S_1 (Fig. 2), which lights the rectifier filament and the filaments of the amplifier valves; after a moment or two the output switch S_2 is closed and H.T. and field current are, therefore, supplied.

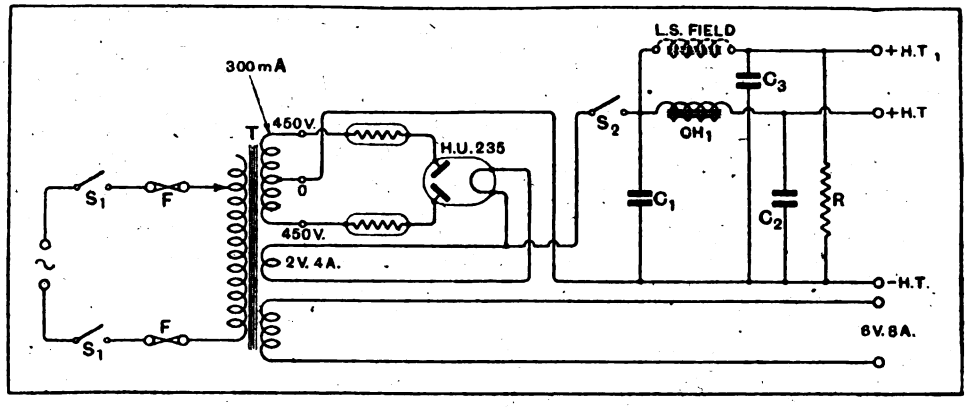

Fig. 2.—Circuit with provision for supplying the field of a 20 watt 200 volt loud speaker. A gas rectifier is employed. CH_1 is an E. 166 Rich and Bundy choke. C_1 6 mfds., C_2 2 mfds., 1,500 volt D.C. test.

In the circuit diagram, Fig. 2, provision is made for supplying the field of a 20-watt 200-volt loud speaker, the loud speaker field winding being used as an auxiliary choke for the first valve, which was an AC/HL.

The September "Call Book."

The Radio Amateur Call Book for September has now been issued. The list of amateur call-signs in all parts of the world, which has been revised and brought up to date, occupies 106 closely printed pages. It includes the latest Australian and New Zealand stations, the Dutch East Indies, and the revised Swedish call-signs.

The publishers earnestly request the help of transmitters in correcting and adding new calls to the list, and amateurs in Great Britain are asked to send particulars of new stations identified or alterations in addresses to Mr. F. T. Carter, Flat A, Gleneagle Mansions, Streatham, London, who is their British representative and from whom copies of the Call Book may be obtained.

Other useful features of the book are the revised "Q" code, International Prefixes, a list of about 1,400 short-wave stations arranged in order of frequencies, and a map of the United States, showing the boundaries of the various Radio districts.

o o o o

Broadcasting in Siam.

Experimental short-wave broadcasting is being carried out by the Royal Siamese Post and Telegraph Department from their stations in Bangkok. HS1PJ transmits on a wavelength of 16.9 metres with an input of 20 kilowatts on Sundays from 12.00 to 14.30 and 18.00 to 20.00 G.M.T. The low-powered station HS4PJ transmits on 37 metres on Tuesdays from 13.00 to 15.00 and 18.00 to 20.00, and on Fridays from 13.00 to 15.00 G.M.T. Announcements are made in English, French, German, and Siamese, and reports of reception will be much appreciated by the Engineering Service, Royal Post and Telegraph Department, Bangkok, Siam.

TRANSMITTERS' NOTES AND QUERIES.

English Amateur in Capetown

Mr. E. R. Cook (G6UO), whose station near Gainsborough was well known to British amateurs, is now in Capetown, where he intends resuming his experimental transmissions on the 20- and 40-metre wavebands. He will use about 600 volts of rectified A.C. on the plate and raw A.C. on the filament of an LS5 valve, giving an input of about 25 watts, and hopes to get into touch with his friends in the Northern hemisphere.

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Short-wave Stations.

We have received, through the courtesy of the Federal Radio Commission, Washington, D.C., a list of radio stations of the world transmitting on frequencies above 6,000 kilocycles (or wavelengths below 50 metres), and comprising about 3,000 stations arranged in order of frequency. The information given includes the call-sign, locality, nature of service and power; also, in many cases, the countries with which any particular station is in regular communication. The nature of service is indicated by letters similar to those used in the "Berne Lists" (e.g., PG=station open to public correspondence, FX=station carrying on services between fixed points), with several additions such as E for Experimental and RBC for Relay Broadcasting. In the case of American stations the name of the company or individual responsible for their working is also given.

The particulars have been compiled partly from the records of the Federal Radio Commission, partly from the lists published by the International Telegraph Union, and from information furnished by the Tropical Radio Telegraph Co., and by various administrations.

The list we have received is in typescript and is, presumably, an advance copy of one to be published by the Radio Division of the Department of Commerce at Washington. If this is the case, we feel sure it will be warmly welcomed by amateurs in this country. It is stated that an endeavour will be made to prepare monthly supplements or correction sheets.

o o o o

Heard in Australia.

We have received, through the courtesy of G2XV, the following list of the European stations heard by Mr. R. Roberts at his station at Box Hill, Victoria, Australia, during July. The strength of signals is given, according to the "R" code, in brackets :—

G5BY (R4), G2XV (R4), G5BZ (R4), G6NH (R3), G2AX (R2), G6WT (R2), G2BM (R2), G5ML (R3), G5YX (R3), F8FR (R4), F8DA (R3), F8FK (R4), F8RKO (R3), ON4EA (R4), ON4FL (R3), ON4HP (R4), ON4FT (R3), D4YT (R4), OZ7Y (R4), CT1BX (R3).

Mr. Roberts states that during July European signals are best received between 2200 and 2300 and between 0600 and 0700 G.M.T.

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TRADE NOTES.

The Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand, London, W.C., announce a change in their telephone number. This is now Temple Bar 4321.

o o o o

A change has been made recently in the telephone number of Messrs. A. C. Cossor, Ltd. This is now North 5900 (20 lines).

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By Our Special Correspondent.

Two Important Ceremonies.—2LO's Last Lap.—A Musical Sensation.

A Foundation Stone Ceremony.

Early this year I suggested that the laying of the foundation stone of "Broadcasting House" should be the occasion of a public ceremony. It now seems that the suggestion will be carried out early in the New Year and, although no definite arrangements have been completed, it is not unlikely that the stone will be "well and truly laid" by one of the most popular members of the Royal Family.

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A Send-off for the Regional Scheme.

The Wireless World has already pointed out that an event of such importance as the inauguration of the Regional Scheme is deserving of more than ordinary publicity. At first it seemed as if the B.B.C. would be content to insinuate the high power transmissions into the ordinary broadcasting periods with an air of apology for disturbing the service. However, some of the old 1922 spirit still bubbles up at intervals, and Savoy Hill has decided that the Scheme is to be given a good send-off in January when the Brookmans Park twins begin simultaneous transmissions. An impressive "S.B." will be staged, in which the inaugural speech will be given by a celebrity of special eminence; indeed, it is hoped that the fateful words will be pronounced by the Prime Minister himself.

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2LO's Last Lap.

One of the most surprising phenomena connected with the opening transmissions from Brookmans Park has been the apparent increase of signal strength from 2LO. I have noticed this especially during the transmission of the Promenade Concerts, and others report the same experience.

It would not surprise some of us if the disclosure were made that Brookmans Park is transmitting at periods other than those officially announced. Possibly, of course, the older station is developing a sprint over the last lap.

The Regional Station will take up the entire London programme at the beginning of next week.

o o o o

Unique Newcastle.

When all six regional stations are functioning listeners in the Newcastle area will possess the unique distinction in the British Isles of still being out of the reliable service range of the new transmitters. So Newcastle will continue to have its own station. For a brief spell in the near future, however, the district will have to forfeit the individuality of local programmes, 5NO being allocated on October 31st next the national common wave of 288.5 metres. From then until the Moorside Edge station is complete (at the end of 1930) Newcastle listeners must submit to a regime of outside programmes.

If they are wise, they will accept the temporary setback in respectful silence, in anticipation of the delights of the future.

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Personalities at the Microphone.

Mr. H. G. Wells will be heard by 2LO listeners on October 21st in a contribution to the series of talks entitled "Points of View."

On November 9th the speech of the Prime Minister at the Lord Mayor's Banquet will be relayed by 2LO and 5XX.

FUTURE FEATURES.

London and Daventry.

OCTOBER 14TH.—"Points of View" (3) by Dean Inge.
OCTOBER 15TH.—Speech by General Dawes at Hull Civic Week Banquet. S.B. from Hull.
OCTOBER 16TH.—"Captain Brassbound's Conversion," by Bernard Shaw.
OCTOBER 17TH.—A Norwegian National Programme.
OCTOBER 18TH.—A Delius Festival Concert.

Daventry Experimental (5GB).

OCTOBER 15TH.—Programme of Plantation Songs.
OCTOBER 17TH.—Selections from the Operas.
OCTOBER 18TH.—"Smoke Rings," a bachelor retrospect by Dorothy Eaves.

Cardiff.

OCTOBER 14TH.—A Welsh Programme.

Manchester.

OCTOBER 14TH.—Gems from Italian Opera.
OCTOBER 16TH.—Speeches at opening of sixth Manchester Radio Exhibition.
OCTOBER 17TH.—Hallé Concert.

Glasgow.

OCTOBER 14TH.—An Hour with Tchaikovsky.
OCTOBER 19TH.—"Jinin' the Kirk," a Scots comedy, by T. M. Watson.

Aberdeen.

OCTOBER 19TH.—A Gaelic Concert.

Belfast.

OCTOBER 19TH.—Speeches at Laying of Foundation Stone of New Law Courts.

The Manchester Radio Show.

Speeches at the opening ceremony of the sixth Manchester Radio Exhibition will be relayed from the City Hall for the benefit of Manchester listeners on October 16th, beginning at noon.

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A Present for "P.P."

The large-hearted staff at Savoy Hill are now putting their pennies together for a handsome presentation to Captain Eckersley, who terminated his appointment as Chief Engineer on September 30th. There seems to be some doubt as to what would be an acceptable present, but I am authoritatively informed that it will not be a wireless set.

o o o o

A Musical Sensation.

One of the best indications that the National Symphony Orchestra (which begins broadcasting on October 25th) will aspire to something above the ordinary standard of broadcast orchestras is the news that its leader will be one of the best known solo violinists of to-day. It is rare indeed for a soloist of rank to take up orchestral work, and I am sure that the forthcoming disclosure of the name of this artist will not only cause a lifting of brows among the high brows, but a big advance in the prestige of the National Symphony Orchestra.

The first concert will be given at the Queen's Hall on October 25th, Sir Henry Wood conducting.

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Football Broadcasts Begin.

The first running commentary of the season on a soccer match will be heard by 2LO and 5XX listeners on Saturday next, October 12th, when the second half of the Arsenal v. Derby County game will be relayed from Highbury at 4.15 p.m.

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Archbishop of York and Broadcast Education.

Public opinion can veer round with surprising rapidity, an instance of this being the changed attitude to broadcast education. Although opposition is still strong, a large section of the public is taking an interest in the plans of the Central Council for Broadcast Adult Education, the new chairman of which is the Archbishop of York. It is hoped that His Grace will be able to preside for the first time at the next Council meeting on Wednesday, October 23rd.

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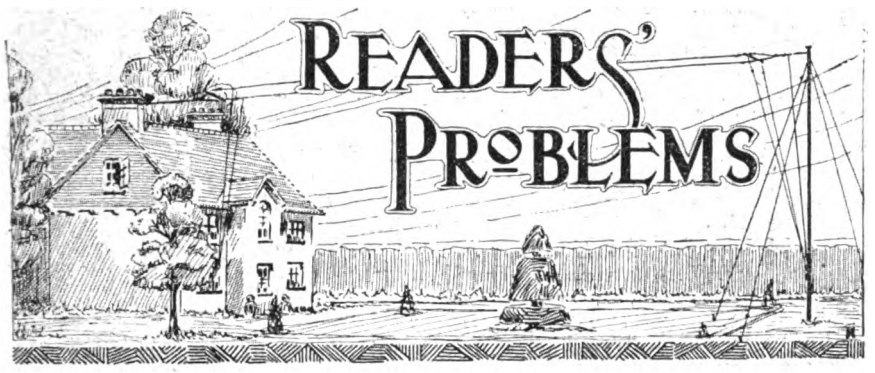

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Modifying the "Kit Set."

In this neighbourhod we are not normally troubled by interference, due to the fact that we are remote from any transmitting station. In these circumstances, do you consider that it would be permissible to modify the "Wireless World Kit Set" by omitting the separately tuned aerial circuit, and, if so, will you give me a diagram showing how it can be altered? T. M. S.

There is no real reason why you should not omit the tuned aerial circuit, but it should be realised that, apart altogether from the question of selectivity, the general performance of the receiver will be adversely affected, but only to a small extent.

We assume that you wish to retain the feature of waveband switching, and give in Fig. 1 a circuit diagram showing how the necessary alterations may be made. A tapping to the aerial connection should be made at the 12th turn from the end, marked x, of the short-wave grid coil L, while a similar connection may be made on the long-wave coil (L_1) at the 35th turn.

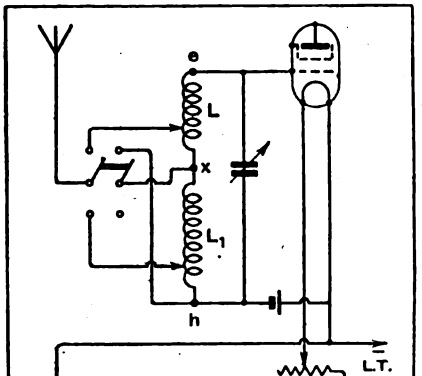

Fig. 1.—Modified H.F. grid circuit of the "Wireless World Kit Set," showing how provision may be made for an "aperiodic" aerial coupling with waveband switching. Lettering corresponds with that in the original circuit diagram.

o o o o

Choke Filter or Output Transformer.

I am building a four-valve set consisting of one H.F. stage, detector, and two L.F. stages. I intend to use an ordinary cone loud speaker, but am uncertain whether it is better to use an output transformer or choke filter output circuit. D. M. P.

Both of these instruments would give you the same results from the musical point of view, as we assume, in the absence of information to the contrary, that the loud speaker you propose to use is not designed to be employed in conjunction with a step-down transformer. From the point of view of stability, however (more especially if you intend to use a battery eliminator), we think that it would be preferable to use a choke filter output circuit.

o o o o

A Temporary Makeshift.

I am thinking of building the "Record III" receiver. As A.C. power will not be available for some weeks in my district, would it be possible for me to use battery-operated valves in the receiver for the time being? H. S. H.

You do not make it quite clear in your letter whether your idea is to use the ordinary type of valves made for battery use, or whether you intend to operate A.C. valves from batteries. If the latter is the case, you can, of course, operate the set entirely from batteries, but it must be pointed out that the filament current taken by the set is naturally very heavy, and therefore it would not be an economical proposition from the point of view of accumulator charging; apart from this, you would have to use an accumulator of generous ampere-hour capacity to enable it to be discharged at a relatively high rate without injury. This would rule out many of the ordinary accumulators now in use.

If you intend to use ordinary battery-operated valves, we would inform you that this plan is quite feasible, but you will have to temporarily alter the filament wiring and probably make some adjustment in the matter of the primary turns on the H.F. transformer. Needless to say, results will be *comparatively* poor to those obtained when using the A.C. valves for which the set is specially designed.

o o o o

Copper or Tin?

I notice that in many of your set designs published last year copper or aluminium screening boxes were adopted. Am I correct in assuming that these are to be used in the "New Kilo-Mag Four" and the "Record III."? L. T. P.

It will, of course, be quite in order for you to use copper or aluminium screening boxes, and, indeed, a copper box is the best to use, but tinned iron, which was actually used in one of the receivers to which you refer, is for all practical purposes equally as good.

You must not expect, however, that by using copper you will obtain better results.

o o o o

A Fuse Question.

I have recently inserted a safety fuse in my "Everyman Four" receiver; this consists of a small flash-lamp bulb connected between H.T.— and L.T.—. Although the set has been functioning well for some time, I find that this lamp speedily burns out. N. C. J.

The total plate current consumption of this set, if built as described, is well under 20 milliamperes, and the bulb should not, therefore, burn out. We think that you have not provided us with sufficient information, and are possibly using an arrangement of two valves of the LS5A type in the last stage, and in this case it would be perfectly normal for the bulb to burn out, if (as we suppose) it is of the special type now available for use as fuses in sets not employing heavy H.T. current.

If you let us have some more information we will endeavour to assist you further.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Building an Eliminator.

Can you give me a circuit diagram for an eliminator which would be suitable for operating a five-valve receiver? W. M. D. M.

You have omitted to state whether your mains are A.C. or D.C., but we can in either case refer you to an instrument which is quite suitable for your receiver.

In the case of A.C. we should advise you to make the instrument described in our issues dated December 12th and 19th, 1928, and in the case of D.G, we should advise you to construct the instrument described in our issue of August 28th, 1929.

o o o o

An A.C. "Kit Set."

Will you please give me a few words of advice as to how the "Wireless World Kit Set" may be modified for use with indirectly heated A.C. valves throughout? I take it that the general design need not be altered; but I understand that it will be necessary to rearrange the filament circuits; it is about this part of the receiver that I should particularly welcome your advice. S. H. T.

The design of this receiver lends itself readily to modification for A.C. mains operation, and we think that the circuit diagram given in Fig. 2 will convey all the necessary information to you.

You may find it necessary to make a slight adjustment to the number of primary turns of the H.F. transformers—this depends on the characteristics of the valves used—but, apart from this, no basic modification of the design will be necessary. It will be observed that a single cell is connected in the detector-grid circuit in such a way that it provides a positive bias; in this matter you should be guided by the advice given by the makers of the valve.

In cases where an attempt is made to attain the maximum overall magnification, it is sometimes advisable to connect a condenser of about 0.005 mfd. across each half of the potentiometer, which is shunted across the secondary of the heater transformer.

o o o o

A Two-valve Question.

Hitherto I have not had electric light mains available, but have recently moved into a new house in which D.C. at 110 volts is supplied. My set is a detector and L.F. fitted with a choke filter output circuit, and hitherto I have operated it successfully using 2-volt L.T. accumulator and five 20-volt H.T. units in series. This has given me satisfactory results, the volume being moderate, but ample for my purpose. I obtain the same results using batteries in my present house, but desire to use the household mains for H.T. supply as my H.T. units are now over three years old, and do not hold their charge for as long as they did. I should be glad if you could tell me what precautions I should take in order to avoid "motor-boating." I have already purchased an eliminator J. F. J.

You do not give us any technical data concerning the particular eliminator you have purchased, but the type of receiver you have in use will operate with almost any kind of eliminator without giving this particular trouble. We may presume that you have purchased a fairly simple instrument having two tappings, one of which is intended for the detector valve.

We would point out that as your mains are only 110 volts, you will not get enough voltage on your last valve to give you undistorted results unless you are content with comparatively little volume. We should advise you to use one of your accumulator units in series with your eliminator. It should be connected between the H.T.– terminal of the eliminator and the H.T.– terminal of the set. If your existing units do not hold their charge for long, it is advisable to purchase at least one new 20-volt unit to use in this position. If two are purchased you can arrange to charge one while the other is in service.

Naturally, we presume that you have an up-to-date receiver, but if not, you must remember that it is necessary to use fixed condensers in aerial and earth leads.

For further information, we would refer you to an article appearing on page 529 of our May 22nd, 1929, issue.

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Special Screening Cabinets.

Will you please tell me if there is any real reason why conventional screening boxes should not be used in the construction of recent Wireless World *sets, for which the new design of metal cabinet is specified? I ask the question because I have a large collection of copper boxes with well-fitting lids.* W. M. P.

If the screening provided by your boxes is as thorough as that of the cabinets used in the construction of the sets to which you refer, there is no reason why they should not be used with satisfactory results. All the new sets are on entirely straightforward lines, and, provided adequate means are taken to ensure sufficient isolation of the various circuits, it matters not at all how this end is attained.

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The Range of a "1-v-1" Set.

I live about 160 miles from Daventry, and on account of morse interference depend almost entirely on the long wave station for consistent reception. I am thinking of replacing my det.-2 L.F. set with an H.F.-det.-L.F. three-valve receiver with anode bend detection and transformer coupling. The set will be fed entirely from A.C. mains, and the most efficient modern valves will be used; do you consider that this circuit arrangement should provide really adequate volume with a reasonable margin of safety? W. J. R.

In answering queries of this sort, we can only assume that your local receiving conditions are not abnormal, and, this being so, it can be stated quite definitely that a well-designed modern three-valve set, with a reasonable aerial and efficient valves, will give an output sufficiently great for average requirements. The efficiency of a modern H.F. stage is so high that it is quite conceivable that you will find it necessary to reduce sensitivity in order to prevent detector —

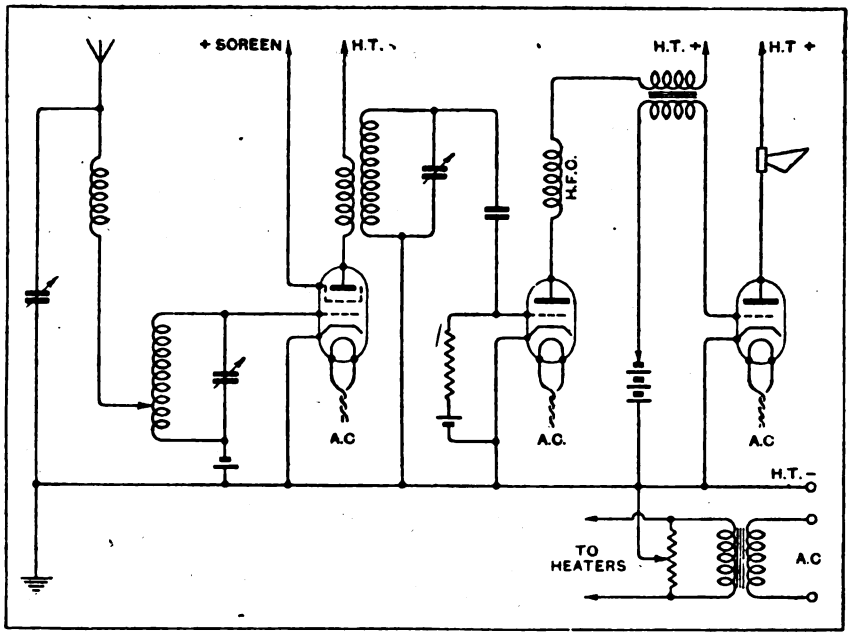

Fig. 2.—Skeleton circuit diagram (omitting waveband switching, reaction, by-pass condensers, etc.) of the "Wireless World Kit Set," modified for use with A.C. valves.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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MUST THE REGIONAL SCHEME BE SCRAPPED?

IT was expected that Monday, October 14th, would have seen the eclipse of the old Oxford Street transmitter of 2LO in favour of Brookman's Park, which it was announced officially by the B.B.C. would take over the whole of the London programme transmission from that date; but for some reason which, at the moment, has not been disclosed, the complete transfer of the programme transmissions to the new station has been postponed.

It is natural that after so much expectancy the public should be interested to learn just what is the real reason for the postponement. One can only venture a guess, and since on the engineering side there has already been ample evidence that the quality and the performance of the station is satisfactory, one must look elsewhere for the cause than to any technical trouble. Is it that, judging from reports of listeners, which must already have been pouring into the B.B.C. as a result of the preliminary trials from Brookman's Park, the B.B.C. are not yet prepared to face the deluge of criticism which we feel sure must fall upon them when Brookman's Park takes over? The daily Press, we observe, has awakened to the troubles of listeners who find that the transmission from Brookman's Park deprives them of programmes from farther afield, and if this is the state of affairs to-day, what is going to be the position if a second programme starts up from the same centre?

Our Views Unchanged.

Our criticism of the power of the Regional stations is not an attitude of recent growth, and we think that the present is a suitable occasion to quote the views which we expressed in our issue of March 2nd, 1927, when, under the title of "The Next War," we wrote:—

"On the face of it the scheme seems to have much to recommend it, provided that one is confident that distribution of programmes over the whole country can be obtained with the four stations (*four or more stations were originally proposed*), but where we find fault with the proposal is in the suggested power of the stations. With many listeners the complaint at present is that it is difficult to cut out the local station if you are anywhere near it, on account of its power. What, then, will be the position when we have two transmissions on 50 kW. in our neighbourhood? Has the B.B.C. quite forgotten its former concern for the interests of the crystal user, for with unselective sets it seems difficult to believe that, close up to a 50 kW. station broadcasting independent programmes on two wavelengths, it will be possible to have a choice of programmes; rather it would seem that two programmes will always be available, but not necessarily as alternatives!

"But there will be a later opportunity for discussing the details of any scheme contemplated. For the moment our desire is to express our disagreement with any proposal which calls for the employment of unnecessarily high power. We believe that in arranging stations and their power to provide for national broadcasting the endeavour should be made to keep down the power so that transmissions do not carry far beyond the frontiers of the country concerned, except, perhaps, in the case of one high-power station for international communication when required.

"As things stand at present the power of stations in Europe is constantly being increased in order to overcome interference from neighbouring stations.

"The first wars of history were almost invariably fought as a result of incursions being made into neighbouring territories; at a later date wars more frequently started because one nation trespassed upon the trade interests of another; to-day we have another possible source of friction between nations to take into account in so far as an invasion of the ether by some foreign nation which may interfere with the broadcasting service of neighbours may at any time excite the indignation of the listening public. We have at the moment the one consolation that, judging from popular views on the programmes, the British nation is not likely to be roused to a high pitch of resentment even if some of our home programmes are overpowered by the programmes from the Continent!"

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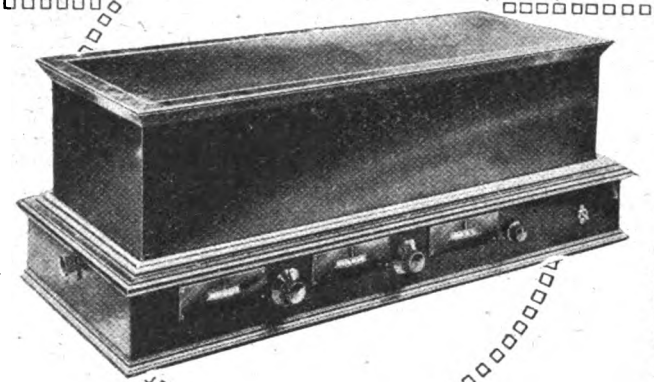
THE 1930 EVERYMAN FOUR

Screen-Grid H.F. Amplification.

Selective Coupled Aerial Circuit.

By F. L. DEVEREUX, B.Sc.



THERE is much diversity of opinion as to the ideal type of receiver for quality reception of the B.B.C. programmes, with occasional explorations into foreign fields. This is hardly the place to go into the pros and cons of the various circuit arrangements at present in vogue; it is sufficient to state that each possesses definite advantages and enthusiastic supporters. One school of thought favours a four-valve combination comprising H.F., detector, and two L.F. amplifiers, and has recruited a formidable army of adherents as a direct result of the introduction of the "Everyman Four" receiver in 1926.

Since that date many changes have taken place, not only in reception conditions in the ether, but also in the characteristics of valves and components. Many enquiries have been received asking if it is possible to introduce these improvements into the original "Everyman Four" design without sacrificing the essential qualities which so largely contributed to the success of the original design. The design of the receiver about to be described has been governed by these considerations, and most, if not all, the suggestions put forward have been incorporated.

Naturally, the original sequence of valves has been retained, viz., H.F. amplifier, detector, and two low-frequency amplifiers. Other features of the original design which remain substantially the same are the design of the low-wave grid circuit coils, the anode bend detector with resistance coupling to the first L.F. stage,

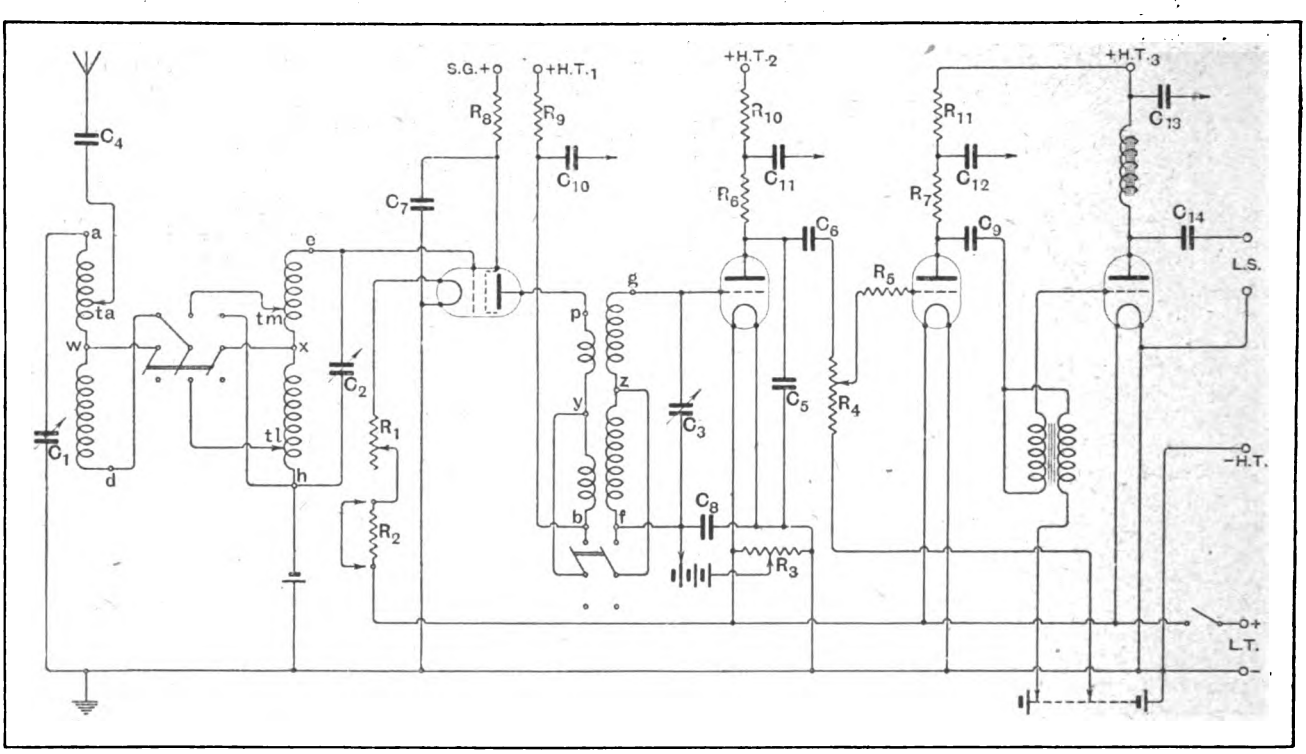


Fig. 1.—The circuit diagram. C_1, 0.0005 mfd.; C_2, C_3, 0.0003 mfd.; C_4, 0.0002 mfd.; C_5, 0.0003 mfd.; C_6, 0.02 mfd.; C_7, 1 mfd (low H.F. resistance type); C_8, C_9, C_{10}, C_{11}, 1 mfd.; C_{12}, C_{13}, C_{14}, 2 mfd.; R_1, 50 ohms; R_2, 0, 12.5 or 25 ohms, depending on filament voltage of valves in last three stages; R_3, 400 ohm potentiometer; R_4, 1 megohm (variable); R_5, 0.1 mehohm; R_6, 250,000 ohms; R_7, 30,000 ohms; R_8, R_9, 600 ohms; R_{10}, R_{11}, 20,000 ohms. The coil connections are lettered to correspond with Figs. 2 and 4.

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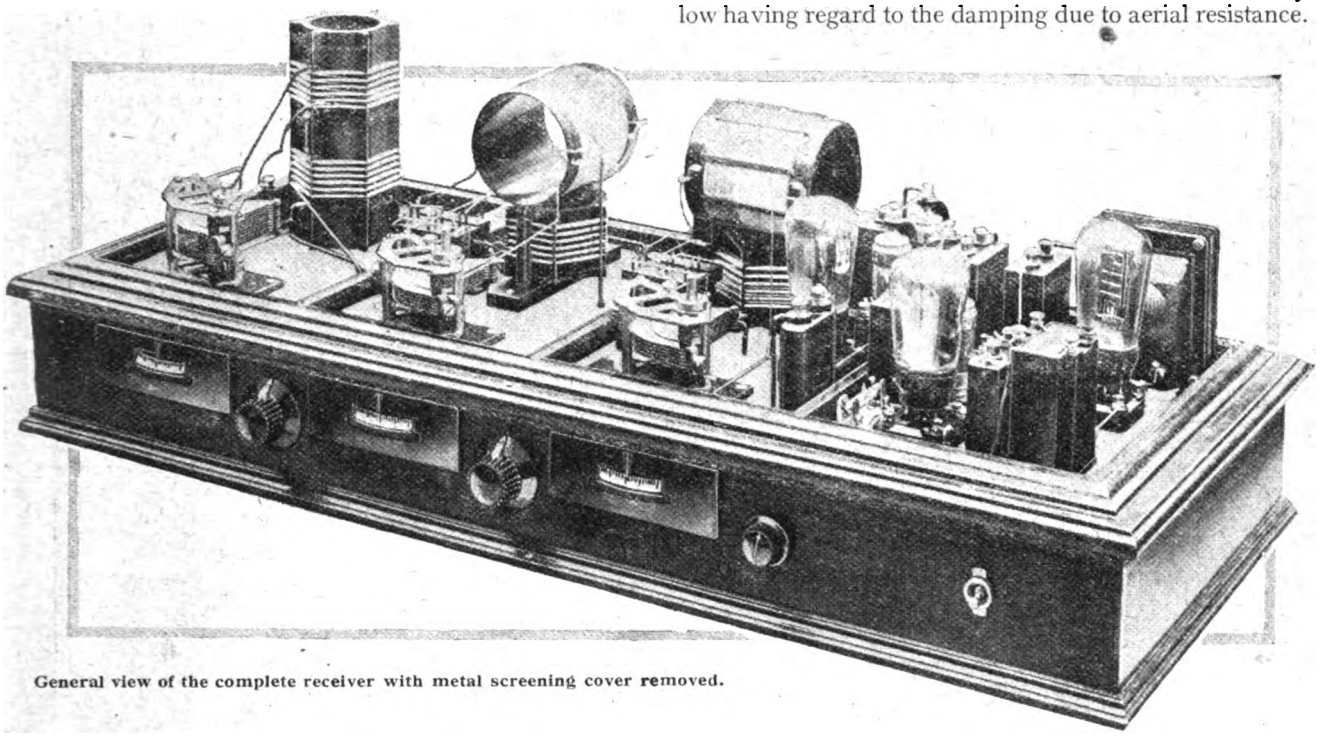
The 1930 Everyman Four.—

and transformer coupling between the first L.F. and the output valve.

Perhaps the most important modification is the introduction of H.F. amplification on long waves. To accomplish this successfully with simple switching arrangements it is necessary, of course, to drop the neutralised triode in favour of the screen-grid valve. This enables us to obtain an amplification in the H.F. stage in excess of the old "Everyman Four" without neutralising; and the change over from long to short waves becomes merely a question of short-circuiting the long-wave windings.

The demand for improved selectivity has been met by the inclusion of a coupled aerial circuit. Unfortunately this introduces a third tuning control, and this is the only feature of the design which compares unfavourably with the original. There can be no doubt that a two-control set possesses many advantages in the matter of easy tuning over the present design with three controls, but conditions in the ether in the near future leave no choice. The coupled aerial circuit, with its extra tuning control, is a necessity if adequate selectivity is to be attained with only a single stage of H.F. amplification.



General view of the complete receiver with metal screening cover removed.

Two important improvements have been made in the low-frequency part of the receiver, namely, the introduction of a post-detector volume control and a filter-feed circuit in the output stage. The volume control enables the detector to function with an increased H.F. input and greater efficiency without overloading the last stage, while the filter output circuit protects the loud speaker windings and prevents the circulation of strong L.F. currents in the H.T. circuit. A further improvement has been the incorporation of anode feed resistances and condensers which effectively prevent any possibility of "motor-boating."

Finally, the receiver has been assembled in a standard four-compartment metal cabinet of the "Kilo-Mag. Four" type, which not only simplifies the work of construction but provides all the necessary screening for the H.F. and coupled aerial circuits. A further advantage of this cabinet is the provision of a screen between the detector and L.F. compartments, which assists in preventing H.F. straying into the L.F. amplifier.

The foregoing covers the outstanding deviations from and additions to the original design. We may now consider the technical aspects of the new circuit in detail.

The tuned aerial circuit is housed in the compartment at the extreme left of the metal cabinet. The coils are section-wound, and their H.F. resistance is sufficiently low having regard to the damping due to aerial resistance. In order to reduce aerial damping a series condenser is included in the aerial lead, which is connected to a point near the low-potential end of the medium-wave coil. To tap down the long-wave coil also would involve the use of an additional set of contacts on the change-over switch. This is obviated by the arrangement shown, for the tapping reduces the damping to the required figure on low waves while the small series aerial condenser looks after the long waves.

The aerial circuit is coupled to the secondary or tuned grid circuit by including a few turns of the secondary coils in the aerial circuit. A three-pole change-over switch short-circuits the long-wave coils of both aerial and secondary circuits, and also transfers the grid circuit tapping to the appropriate coil.

The secondary circuit is given a compartment to itself (the second from the left). The medium-wave coil follows standard "Everyman Four" practice in that it is wound with 68 turns of 27/42 Litz on a 3in. diameter

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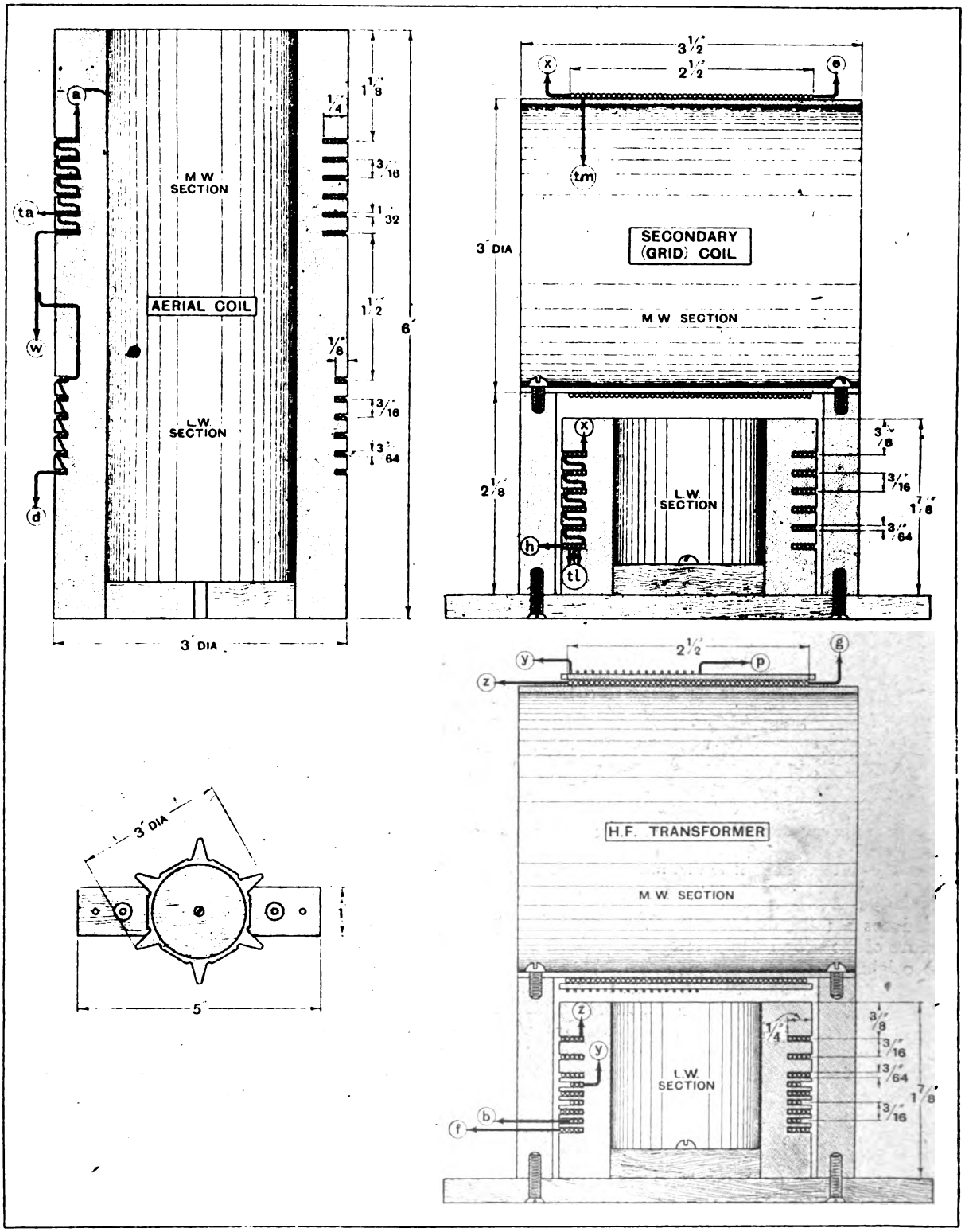

Fig. 2.—CONSTRUCTIONAL DETAILS OF COIL UNITS. The windings require the following turns and tappings. AERIAL COIL, Medium wave: 6 slots, 8 turns per slot No. 26 D.C.C., tapped at 40th turn from start (a), Long wave: 6 slots, 25 turns per slot No. 32 D.S.C. SECONDARY (GRID) COIL. Medium wave: 68 turns 27/42 Litz tapped at 2nd turn from low potential end (X). Long wave: 6 slots, 35 turns per slot No. 32 D.S.C., tapped at 3rd, 5th and 6th turns from low-potential end (h). H.F. TRANSFORMER. Medium-wave primary (for Mazda S.G.215 valve): 30 turns No. 38 D.S.C., spaced 30 turns per inch on 9 ebonite spacing strips. Medium-wave secondary: 68 turns 27/42 Litz. Long-wave primary: 3 slots, 30 turns per slot No. 40 D.S.C. Long-wave secondary 6 slots, 30 turns per slot, No. 35 D.S.C. All windings are wound in same direction on each former and the lettering corresponds with Figs. 1 and 4.

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LIST OF PARTS.

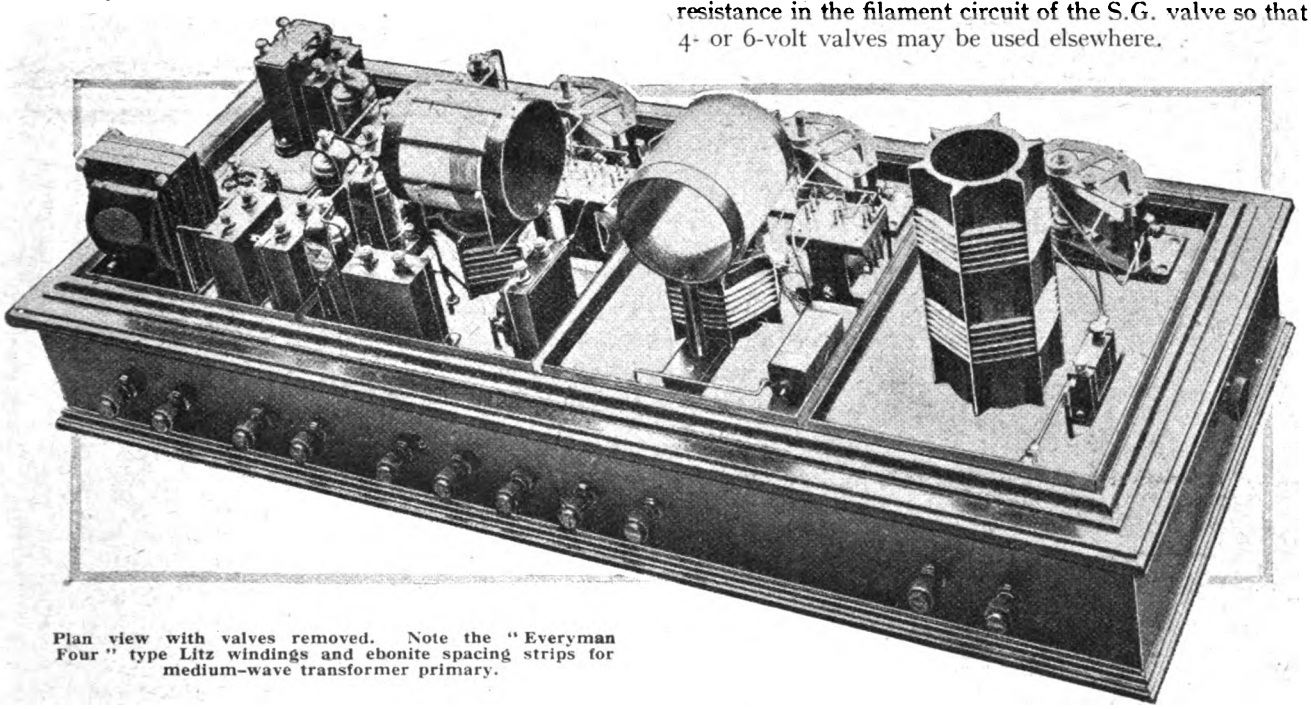
1 *Special metal container (Rigby & Woolfenden, Rochdale).*
2 *Variable condensers, 0.0003 mfd. (J. B. "Universal Log.").*
1 *Variable condenser, 0.0005 mfd. (J. B. "Universal Log.").*
3 *Special dials and escutcheon plates.*
1 *Fixed condenser, 0.0002 mfd. (Dubilier, No. 620).*
1 *Fixed condenser, 0.0003 mfd. (Dubilier, No. 620).*
1 *Fixed condenser, 0.02 mfd. mica (Dubilier, No. B. 775).*
3 *Fixed condensers, 1 mfd. (Dubilier, B.T. type).*
4 *Fixed condensers, 2 mfd. (Dubilier, B.T. type).*
1 *Fixed condenser, 1 mfd. (Dubilier, LAA type).*
3 *Valve holders (Bowyer-Lowe "White Line.").*
1 *Valve holder (Aermonic "A" type).*
1 *Switch, 3 pole D.T. (Utility, Lever pattern).*
1 *Switch, 2 pole D.T. (Utility, Lever pattern).*
1 *L.F. transformer (R.I. "Hypermu").*
1 *L.F. choke (Ferranti B.1).*
1 *Special aerial coil.*
1 *Special secondary (grid) coil.*
1 *Special H.F transformer.*
1 *Resistor holder and shorting plug (Burndept).*
2 *Wire-wound resistances, 20,000 (Varley).*
1 *Wire-wound resistance, 30,000 (Varley).*
1 *Wire-wound resistance, 250,000 (Varley).*
1 *Grid leak, 0.1 megohm (Lowe).*
1 *Porcelain holder for above (Bulgin).*
2 *Decoupling resistances, 600 ohms (Wearite).*
1 *Variable high resistance, 1 megohm (Igranic "Megostat.").*
1 *Rheostat, 50 ohms (Ormond).*
1 *Potentiometer, 400 ohms (Ormond).*
1 *G.B. battery, 16½ v. (Siemens).*
1 *G.B. battery, 9 v. (Siemens).*
1 *pr. G.B. clips (Bulgin).*
1 *Cell, 0.9 v. (Siemens).*
5 *Wander plugs (Clix).*
1 *On-and-off switch (Claude Lyons, "QMB" type).*
11 *Terminals, ebonite shrouded (Belling-Lee).*
11 *prs. insulated bushes, 2 B.A. (Igranic).*
Brass strip, Sistoflex, wire, screws, etc.

Approximate cost, including metal cabinet, £15.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer, and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

paxolin former. The long-wave coil is designed in accordance with established practice, and is section-wound in a slotted 6-rib ebonite former. The damping on these coils is much less than in the original "Everyman Four," and they therefore contribute considerably more to the overall selectivity of the set.

The screen-grid H.F. valve is mounted underneath the base, out of the field of the tuning inductances, and in this position acts as a link between the two middle screening compartments of the metal container.



Plan view with valves removed. Note the "Everyman Four" type Litz windings and ebonite spacing strips for medium-wave transformer primary.

After careful consideration it was decided to specify a Mazda S.G.215 valve for this stage. By making this decision it is possible to specify a definite number of turns for the low-wave primary of the H.F. transformer, giving a well-balanced compromise between amplification and selectivity. It was found that the number of primary turns is somewhat critical when using a Litz-wound secondary of high efficiency, and it would be necessary to specify a different number of primary turns for every make of screen-grid valve on the market. This would involve many difficulties in the production of the coils, so that in the interest of all concerned the obvious step has been taken of recommending a single combination of valve and primary winding which has been found to give very satisfactory results. Considerable latitude is possible in the choice of valves for the remaining three stages, and provision is made for the insertion of a fixed resistance in the filament circuit of the S.G. valve so that 4- or 6-volt valves may be used elsewhere.

A by-pass condenser of low H.F. resistance for the screen-grid is essential, and accordingly a Dubilier type LAA has been specified for this position. The grid is biased by a special 0.9-volt cell, which effects a considerable improvement in the valve characteristics.

We come now to the detector stage, which occupies the third compartment from the left. The assignment

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The 1930 Everyman Four.—

of suitable values for the components involved in this stage is perhaps the most difficult task which confronts the designer of a receiving set. It is necessary to effect a compromise between the following conflicting factors:—

(1) Detector efficiency, i.e., L.F./H.F. ratio for both large and small inputs.

(2) Grid circuit loading.

(3) High-note loss.

(4) H.F. leakage to the L.F. amplifier.

(5) Post-detector volume control, the operation of which does not affect any of the foregoing conditions.

In order to attain a high detector efficiency, the anode resistance should be large compared with the A.C. resistance of the valve under working conditions, while the by-pass condenser should have a high value to prevent reduction of the H.F. input due to grid circuit

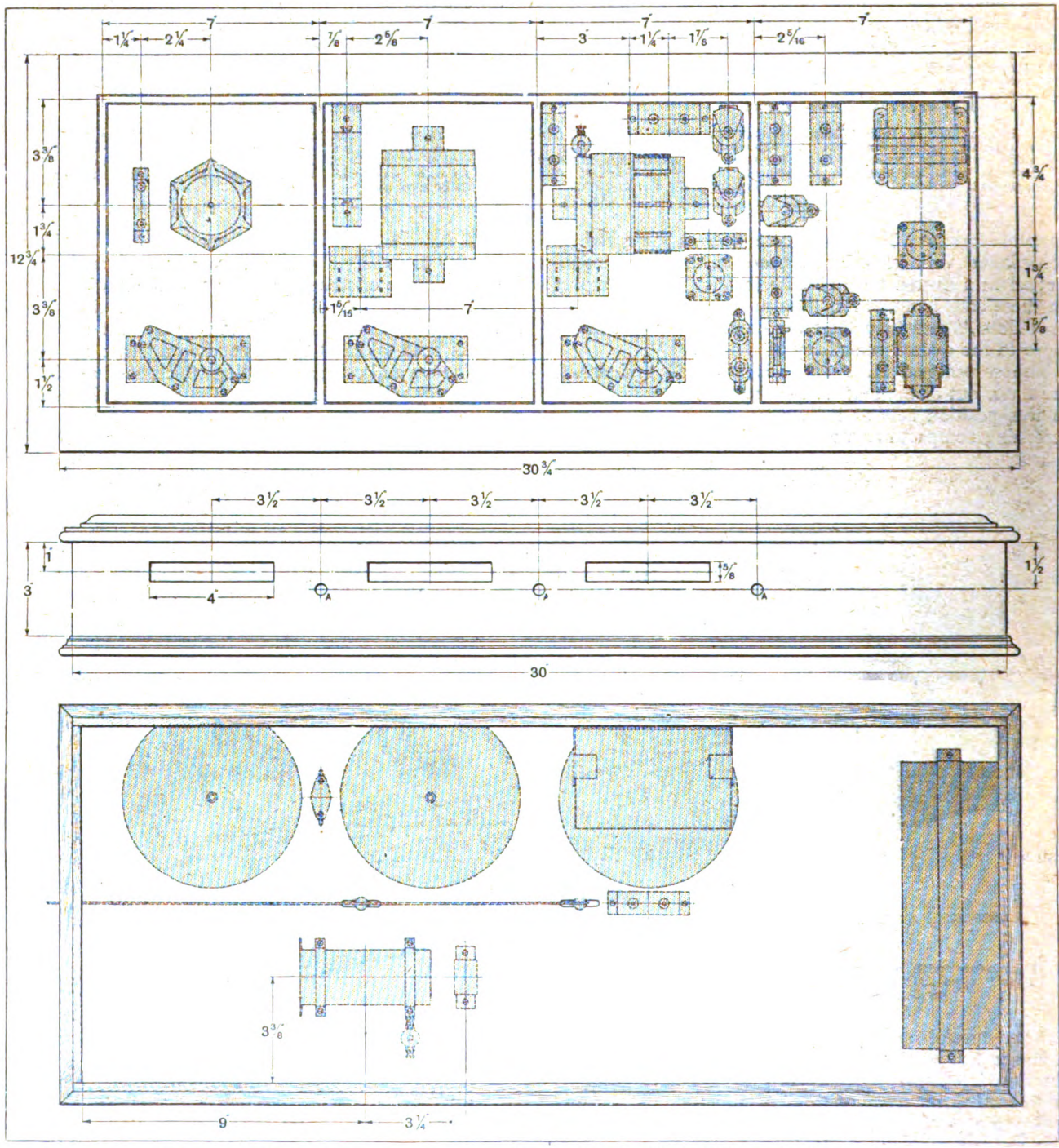

Fig. 3.—Layout of components above and below baseboard. The holes A are ⅛in. in diameter.

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The 1930 Everyman Four.—

loading. Unfortunately, high note loss sets a limit to the capacity of the by-pass condenser, and it is necessary to steer a middle course between these two conflicting factors. There is little point in using a valve of lower A.C. resistance with a reduction in the anode circuit resistance as a much larger by-pass condenser has to be used to bring the grid current loading to the same figure, and by the time this has been done the high note loss is equivalent to the case of the high resistance valve. In general the high resistance combination is more sensitive to weak signals and has therefore been specified in the design.

Detector Grid Bias.

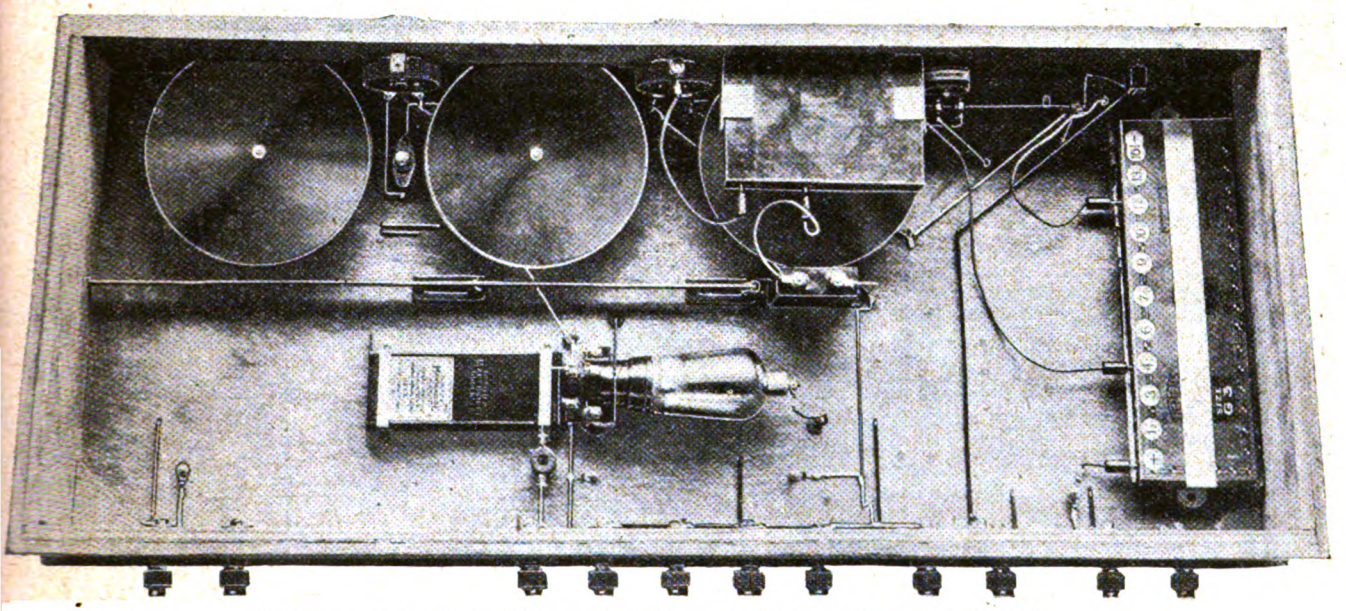
The value of the grid bias and the magnitude of the H.F. input also has some bearing on the grid circuit loading, which is reduced when the negative bias is increased. The introduction of a post-detector volume control permits this adjustment, for the H.F. input can be increased in accordance with an increased negative bias without necessarily overloading the output valve. A potentiometer has been included for critical adjustment of the grid bias.

The values specified in the diagrams are the result of actual measurements on the factors (1) to (4) set out above. An experimental detector stage with a special low-loss tuned input circuit, sensitive to grid damping, was energised by means of a modulated H.F. oscillator. The H.F. input and L.F. (and any H.F.) output could be measured simultaneously. Variations were made in the type of valve, values of anode resistance, by-pass condenser, etc., and for each new set of conditions readings were taken for the detector efficiency with 600 and 6,000 cycle modulation, and the depression of the input circuit volts due to switching on the valve. Tests were also made for H.F. in the L.F. output circuit. The results show that no drastic modification of the original design is necessary at this stage. A slight loss of high notes was permitted in the interest of conditions (1), (2) and (4) above, in view of the fact that the upper frequencies are reinforced in the succeeding stage.

An R.I. "Hypermu" transformer was chosen to couple the first L.F. amplifier to the output valve, since this component, when connected as an auto-transformer and freed from direct anode current by means of a resistance-capacity filter, shows a marked rising characteristic (*vide* N.P.L. curves).

The remainder of the circuit is self-explanatory and does not call for special comment.

The work of assembly and wiring is so greatly simplified by the special form of metal cabinet that detailed description is superfluous; all the necessary information is crystallised in the working drawings and wiring diagram.



View underneath base showing disposition of detector and L.F. grid bias batteries.

It is important that the low-frequency transformer connections should be made exactly as indicated in the wiring diagram, while if the volume control grid leak is of the logarithmic type care should be taken that the end connections are not reversed, otherwise the change in volume will be crowded to one end instead of being distributed evenly over the range of movement of the dial. In the case of the Igranic "Megostat" the red terminal should be joined to grid bias and the blue to the coupling condenser.

Valves and H.T. Voltages

Suitable H.T. and grid bias values will depend on the valves, and should be fixed in accordance with the maker's recommendations. It has already been stated that a Mazda S.G.215 valve should be used in the first stage A general purpose (H.L.) valve having an A.C. resistance of about 25,000 ohms and amplification factor

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The 1930 Everyman Four.—

20 to 25 is suitable for the detector, while the first L.F. amplifier should be a type "L" valve of about 10,000 ohms resistance (amplification factor 10). The output valve may be of the "power" or "super-power" type according to the requirements of the individual.

If 2-volt valves are used throughout a shorting plug must be inserted in the fixed resistor holder R_2. With 4-volt valves in the last three stages a 12.5 ohm resistance will be required, and with 6-volt valves 25 ohms.

For the initial tests the following H.T. voltage will be suitable, minor alterations being made by experiment until best results are obtained: H.T.$_1$, 120 volts; H.T.$_2$, 100 volts; H.T.$_3$, 150 volts; Screen, 60 volts.

In conclusion, it can be definitely stated that the H.F. amplification is at least double that of the original "Everyman Four" employing a neutralised three-electrode valve, while tests have proved that the selectivity is more than adequate for long-distance reception under the new Regional conditions.

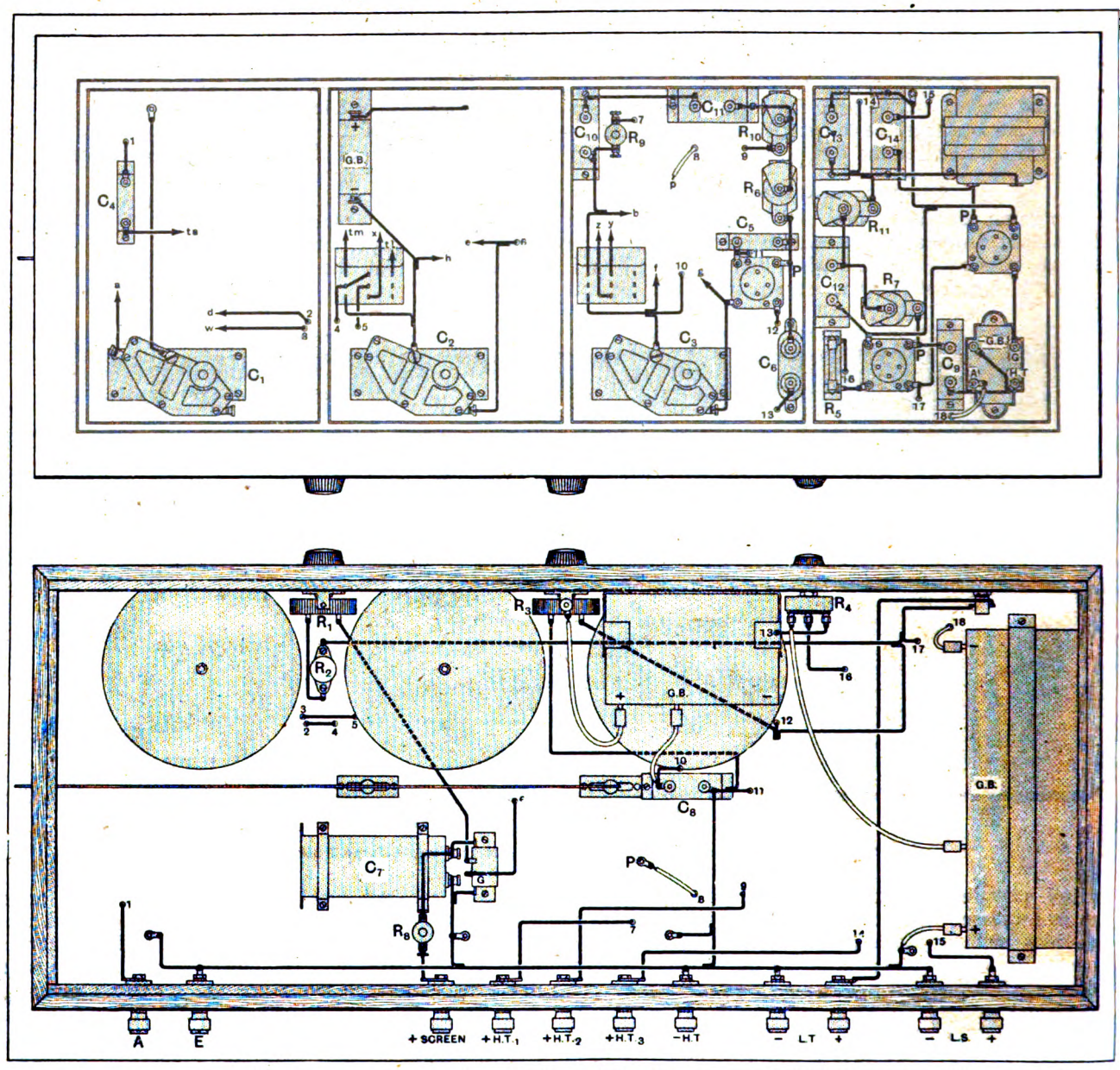

Fig. 4.—Complete wiring diagram. Connections to the coil units are lettered to correspond with Figs. 1 and 2. The red terminal of R_4 goes to grid bias and the blue to C_6.

This receiver, together with other sets recently described in these pages, will be available for inspection on The Wireless World *Stand (No. 34) at the Manchester Radio Exhibition.*

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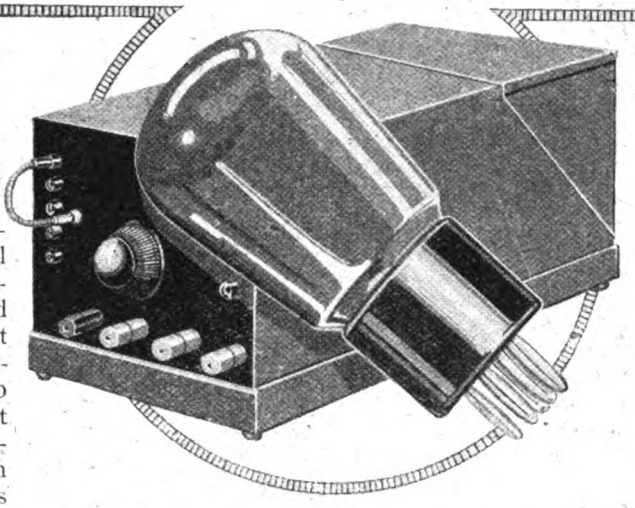
A NEW HIGH-VOLTAGE PENTODE

Public Address Volume with 250 Volts.

Characteristics of the New PM.24A Valve.



ONE of the chief drawbacks to the original pentode valve, introduced by Messrs. Mullard just over a year ago, is that it is rated for an anode voltage not greater than 150 volts. A pentode is not usually incorporated in a receiver for the sake of its high amplification, though this is always very acceptable, but rather because it will give, without overloading, a greater output of signals than can be attained from a triode operated at the same anode voltage. In view of this fact it has always been rather annoying to find that the makers have hitherto restricted us to a maximum of 150 volts on the anode, especially as 200 volts or over is directly available from most D.C. mains, and from many eliminators used on A.C. supply. As there are several triodes on the market capable of standing up to these slightly higher voltages, the restriction has, in the past, seriously curtailed the usefulness of the pentode, for one of these triodes, operated at full voltage, would provide nearly as great an output as the pentode at its maximum rating.

The new Mullard PM.24A is a much more tempting proposition from the point of view of the designer of a set for mains operation. It is rated to withstand up to 300 volts on the plate, with a maximum of 200 volts on the screening-grid. It may, therefore, be put straight into an all-mains receiver and be allowed to operate on the full voltage available from the mains.

In appearance, there is no difference between the new valve and the familiar PM.24, its low-voltage prototype. It is available, however, with the five-pin base recently adopted for indirectly heated mains valves, the screening-grid being, in this case, brought out to the centre pin which is used, in an indirectly heated triode, for the cathode connection.

The makers give the following data for the valve:—

Filament Voltage	...	4.0
Filament Current	...	0.275 amp.
A.C. resistance	...	53,000 ohms.
Amplification Factor	...	83
Mutual Conductance	...	1.56 milliamps. per volt.

The conditions in which the figures for A.C. resistance and amplification factor are obtained are not stated; the standard conditions for a triode are anode volts 100, grid volts zero.

Operating Data.

Since there would be no point in choosing this valve, rather than its less robust brother, the PM.24, unless the use of a voltage higher than 150 were contemplated, the curves for this valve were all taken with the permitted maximum of 200 volts on the screening-grid. With this voltage applied to both screening-grid and anode, the anode currents corresponding to various grid voltages were measured, and are plotted in Fig. 1. The slope of the curve in the neighbourhood of 20 to 25 milliamps., which represents normal operating conditions, is 1.85 milliamps. per volt. It will be seen that this is a little higher than the figure of 1.56 quoted by the makers, and indicates that the valve is conservatively rated. Another curve was also taken, with the same voltage on the screening-grid, but with 300 volts on the plate. At all points this second curve shows about 3 per cent. greater anode current than that of Fig. 1; it is not reproduced on the diagram because the closeness of the two curves would make both difficult to read, while if we allow for permissible variations from valve to valve, that shown may be taken as valid for any anode voltage between 200 and 300. Thus, as might be expected, the screening grid voltage exerts more influence on the anode current than the anode voltage.

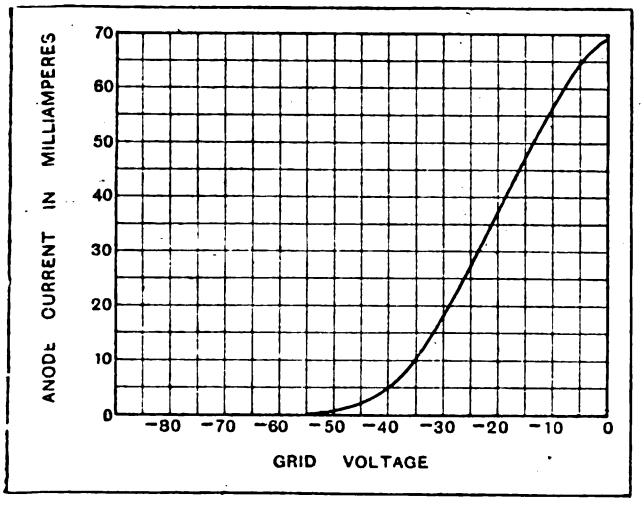


Fig. 1.—Characteristic of the PM.24A with anode and screen voltages of 200. The curve is little changed by substituting anode voltages from 150 to 300.

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A New High-voltage Pentode.—

The operating instructions given with the valve include the following table:—

Anode Volts	100	150	200	250	300	
Grid Bias Volts	9	15	21	27	33	
Anode Current	8	11	15	19	23	milliamps.

There is also a statement that the screening-grid voltage must not exceed 200 volts, otherwise the emission will be excessive and the valve may be damaged.

Enormous Power Output.

Thus, we did not venture to increase the auxiliary grid voltage above 200, but kept it at this value while measuring the anode current at a series of anode voltages. The three curves obtained are given in Fig. 2, the grid voltages adopted being those suggested in the last three columns of the table reproduced above from the makers' instructions. The middle curve of the three, corresponding to a grid bias of 27 volts, would appear to represent the normal working conditions, for the standing anode current at 200 to 300 volts is some 23 milliamps., the highest mentioned in the table. The slope of this curve shows that the valve, under working conditions, has an A.C. resistance of about 60,000 ohms, from which, knowing the mutual conductance, we deduce an amplification factor of 110. Both these figures are rather on the high side, but that is a matter of very little importance with a pentode. If a lower impedance together

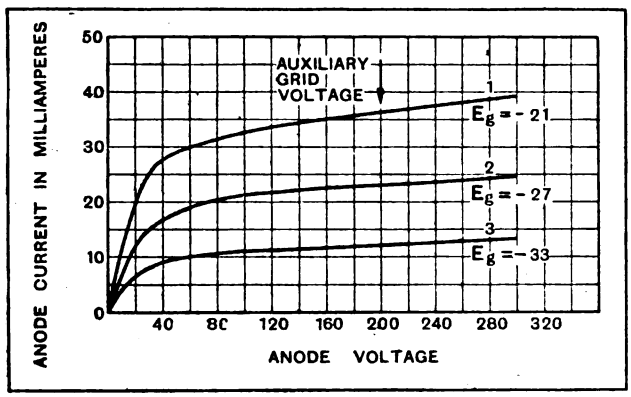

Fig. 2.—Anode voltage-anode current curves when the screen-grid voltage is 200 and the control grid is biased as shown. In curve 1, R_a is 27,000 ohms and $\mu = 54$; in curve 2, R_a = 60,000 ohms and $\mu = 110$; in curve 3, R_a = 80,000 ohms and $\mu = 130$.

with a lower amplification factor is desired, it can be had by choosing the lower value of grid bias that corresponds to the uppermost of the three curves, and which is the actual grid bias suggested in the maker's table of data. The anode current rises then to nearly 40 milliamps., while A.C. resistance and amplification factor become about 27,000 ohms and 50 respectively. Neither the available output nor the amplification yielded by the valve are greatly varied by this change; to the ear, the most significant difference is an increase of bass notes with the lower grid-bias voltage.

The maximum power that can be taken from the pentode is not easy to specify exactly, since it depends to a very great extent on the impedance connected in the anode circuit. If we assume this to be a non-inductive resistance of 10,000 ohms, the audio-frequency power that the PM.24A will deliver to it before overloading commences is in the neighbourhood of 2 to 3 watts. Using a moving-coil of 2,600 turns, fifty to sixty ampere-turns are available to move the coil and the cone attached to it. These figures compare well with the output to be had from a valve of the LS5A variety on its maximum rated voltage of 400.

As a final test, the valve was given a practical trial in a receiver. Using a moving-coil speaker fitted with a special "pentode coil" of 2,500 turns, the volume available before overloading began was found to be greater than could be tolerated in any but a very large room. With the lower plate-current (23 milliamps.) corresponding to a high valve impedance it was noticed that the treble was unduly pronounced; this was easily rectified by connecting the loud speaker to a tapping on the choke, as in Fig. 3. No volume appeared to be lost by so doing.

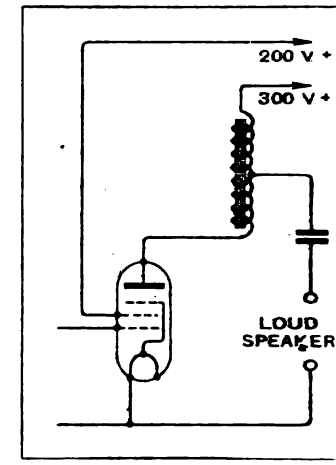

Fig. 3.—The use of a tapped output choke was found to improve quality.

Used with a moving armature speaker, overloading occurred at a much smaller signal strength than with the moving coil, as might be expected from the higher impedance and lower sensitivity of this loud speaker. Nevertheless, quite satisfactory volume was to be had, though the introduction of a 2:1 step-down transformer with a resistance of 20,000 ohms connected across its primary resulted in better quality, with less accentuation of the higher frequencies. These practical tests suggest that the pentode, even more than the triode, is best served with a moving-coil speaker.

We understand that the PM.24A is being fitted to all-mains receivers, in which the filament is heated by alternating current. We ourselves have tried this, and find that no noticeable hum is introduced provided that the usual precautions are taken. Pending the arrival of a pentode specially designed for A.C. mains, the present model may be used with complete satisfaction in A.C. sets, while its extreme suitability for use on D.C. mains, where the high voltages normally associated with an output stage of "public address" dimensions cannot be attained, is very evident indeed.

NEXT WEEK'S ISSUE

will contain a fully illustrated report of

THE MANCHESTER SHOW.

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CURRENT TOPICS

Events of the Week in Brief Review.

WHY NOT IN BRITISH TRAINS?

The news that express trains between Paris and Havre are to be equipped with wireless receivers serves to emphasise the lethargy of the British railway companies in regard to the possibilities of broadcast reception on long-distance runs.

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ANXIETY IN GLASGOW.

Known as "The Terror," the Post Office detector van is now touring the Glasgow district in search of oscillators and "pirates." The equipment in the van includes a screen-grid four-valve set with a frame aerial. The receiver covers a wave range from 15 to 2,000 metres.

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THE POPE'S WIRELESS STATION.

It is announced in the Vatican City that the Italian Government has decided to contribute half a million lira towards the expense of erecting the Papal wireless station now under construction. The apparatus is being built by the Marconi Company. The two masts, each nearly 250ft. high, are being made in Italy.

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WHEN IS A WAVE SHORT?

Many arguments will be settled (or started!) by the news that the International Consultative Committee of the Radio-Electrical Conference now in session at the Hague has decided to classify wavelengths as follows:—

Long, 3,000 and upwards.
Medium, 200 to 3,000.
Intermediate, 50 to 200.
Short, 10 to 50.
Ultra-short, below 10.

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PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION.

The Twentieth Annual Exhibition of Electrical, Optical and other Physical Apparatus is to be held by the Physical Society and the Optical Society on January 7th, 8th and 9th, 1930, at the Imperial College of Science and Technology, South Kensington.

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WIRELESS ON TAP AT SING SING.

The many attractions of Sing Sing prison have been added to by the inclusion of a wireless phone "point" in each of the 800 cells in the new block, says a New York message. It is stated that a prison official chooses what programme shall be relayed to the cells, this precaution being necessary to obviate the possibility of prisoners' friends talking to them *via* a night club microphone!

ALL ROADS LEAD TO MANCHESTER.

To-day (Wednesday) sees the opening of the Manchester Wireless Exhibition at the City Hall. A guide to the show appears on page 437.

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"TALKIES" FOR THE DEAF.

The Paramount "Talkie" Theatre at Brooklyn, New York, has fitted up a portion of the auditorium with amplifiers and an extensive net of headphones for the use of deaf members of the audience. In order to cope with degrees of deafness, the headphones are equipped with a potentiometer to control the volume of sound according to individual requirements.

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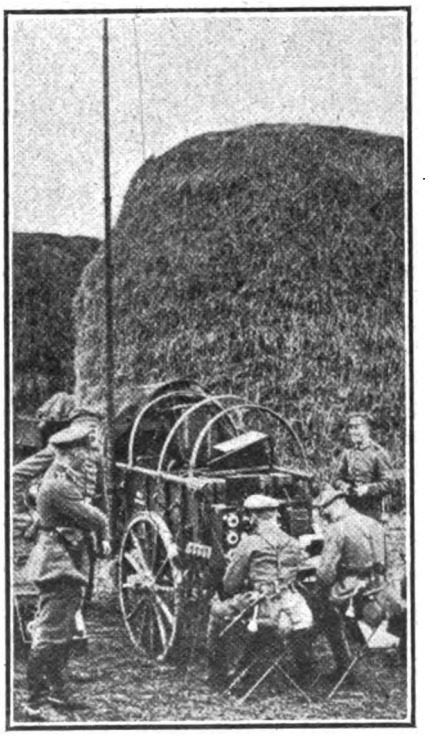
IS YOUR MAST SAFE?

A correspondent in *The Times* has drawn attention to the possibility that many wireless poles erected four or five years ago may now have reached a dangerous condition due to rot at the "wind and water" line, viz., 6in. above and 6in. below ground. *Verb. sap.*



GERMAN FIELD WIRELESS. A photograph taken during the recent Autumn Manœuvres of the German Army. The portable mast is about 20ft. in height.

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POLICING THE U.S. ETHER.

The largest radio frequency measuring station in the world is to be opened next December at Grand Island (Nebraska), U.S.A. It is to be used for checking the wavelengths of all United States transmitters. Roughly, six hundred broadcasters, two thousand ship installations, sixteen thousand amateurs, as well as aerodrome, naval and military stations are expected to avail themselves of this service.

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WIRELESS FOR EVERY BLIND PERSON.

The National Institute for the Blind, which has just published its sixtieth annual report, has a special Technical Research Committee devoting attention to the upkeep of sets owned by blind listeners. It is hoped that schemes will eventually be evolved which will bring wireless to every blind person in the country.

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NOISY LOUD SPEAKERS.

The Health Committee of the Hull Corporation has requested the Town Clerk to draft a bylaw to stop noise arising from loud speakers which are operated in a manner to cause annoyance.

Simultaneously we learn that an organisation of apartment house owners in Brooklyn, N.Y., have decided to incorporate in leases to new tenants a clause prohibiting the operation of loud speakers after 10.30 p.m.

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PAPER CONDENSER PATENT.

The paper condenser is to be the subject of litigation in America, according to a New York correspondent, who states that the Dubilier Condenser Corporation has brought an action for infringement of patent rights against the Aerovox Manufacturing Corporation in respect of U.S. Patent 1,688,478, which relates to the manufacture of paper condensers.

Large sums of money may be involved, as it is estimated that the cost of such condensers used in radio sets and amplifiers amounts to more than twenty million dollars annually. Many important companies in America and Europe have taken licences on a royalty basis.

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Selectivity in Plain Terms

A New Unit and its Applications to Practical Circuits.

By R. T. BEATTY, M.A., B.E., D.Sc.

THE opening of the Brookmans Park Station with a power consumption of 30 kilowatts, ten times as great as that of the old 2LO, is bringing to the fore among listeners in the London area the subject of selectivity in receiving sets and the growth of the regional scheme will ultimately compel interest in this topic to extend over the whole country. For, with the realisation of the regional scheme, the local station will become dominant over a wide sector of the tuning dial, and its elimination in favour of distant stations can only be effected by an increase in selectivity.

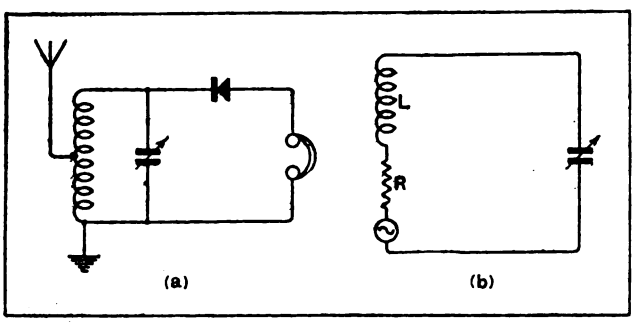

Fig. 1—Simple crystal set and equivalent H.F. circuit.

The discussion of selectivity has been hampered in the past by the lack of an exact definition of the term—a definition, in fact, which will allow us to express the selectivity of a set as a numerical quantity from which we can infer its performance both as regards quality of reproduction and power of separating stations of contiguous wavelengths.

This performance can, it is true, be inferred from the resonance curve of the high-frequency stage or stages of the set, assuming that the low-frequency stage is of sufficiently good quality to cause no serious distortion. But we must admit that the formula which gives the resonance curve is a formidable one, and that even when this formula is mastered the numerical work involved in plotting the curve is laborious.

In this article a proposal will be made to express the selectivity of any set as a numerical quantity, and it will be shown that when this number is known it is but a moment's work to draw the H.F. resonance curve.

Resonance Curves.

A set consisting essentially of a single tuned circuit such as the crystal set shown in Fig. 1 (*a*) is equivalent from the H.F. point of view to the circuit of Fig. 1 (*b*) in which the resistive loads due to the aerial, the crystal and the phones are incorporated as an equivalent series resistance R.

Fig. 2 shows the resonance curve of this circuit: its shape depends solely on the ratio of the reactance of the coil to the series resistance (Fig. 1 (*b*)). This ratio is called the coil magnification. If it is large the curve is steep: if small, the curve is flat.

All these differently shaped curves can, however, be reduced to a single curve by the simple device of plotting them on logarithmic paper. In Fig. 3 the curve corresponding to a single tuned circuit is the same as that of Fig. 2; if now the value of the coil magnification *m* be changed, the shape of this curve is unaltered; it is merely shifted bodily in a horizontal direction (to the right if *m* be decreased, to the left if *m* be increased).

Accordingly, if we copy the curve on a piece of tracing paper and slide the paper horizontally by the requisite amount in any particular case we can obtain immediately the resonance curve for *any* single tuned circuit.

The Selectivity Number.

In order to decide where to put the tracing paper we must fix on some reference point on the resonance

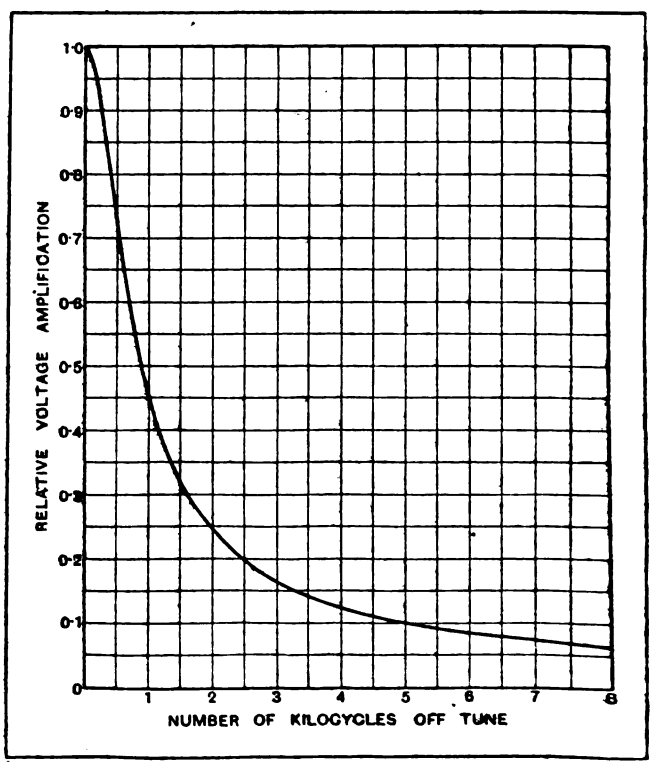

Fig. 2—Typical resonance curve for the single tuned circuit of Fig. 1.

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Selectivity in Plain Terms.—curve; this point we will take to be the intersection of the curve with the cross-hatched horizontal line in Fig. 3, that is, the number of kilocycles by which the circuit must be detuned in order that the ordinate of the curve may fall to 0.1 of its value at resonance. In Fig. 3 this value is 5 kilocycles for all the curves.

The position of this reference point can be found by giving to the single tuned circuit in question a number, called the selectivity number (and this proposal is the kernel of the present article), so chosen that the following statement is true.

The number of kilocycles by which a single tuned circuit must be detuned to cause the ordinate of the resonance curve to fall to 0.1 *of its value at resonance is obtained by dividing the frequency of the carrier wave in kilocycles by the selectivity number.*

Thus, if the frequency of the incoming signal is 1,000 kc., and the selectivity number is 200, the resonance curve will cut the cross-hatched line in Fig. 3 at $1{,}000/200 = 5$ kc.: this is the position actually shown.

It has already been stated that the position of this intersection depends only on the coil magnification m, so that the selectivity number must depend on m.

Actually the relation is very simple: it is shown in the Appendix that for a single tuned circuit the selectivity number is $0.2 \times m$: the example quoted above would consequently refer to a coil with $m = 1{,}000$, which is, of course, much larger than would obtain in a crystal set, where we may expect m to be about 10, and the selectivity number consequently to be $0.2 \times 10 = 2$, so that with a carrier wave of 1,000 kc., the intersection[1] lies at $1{,}000/2 = 500$ kc.

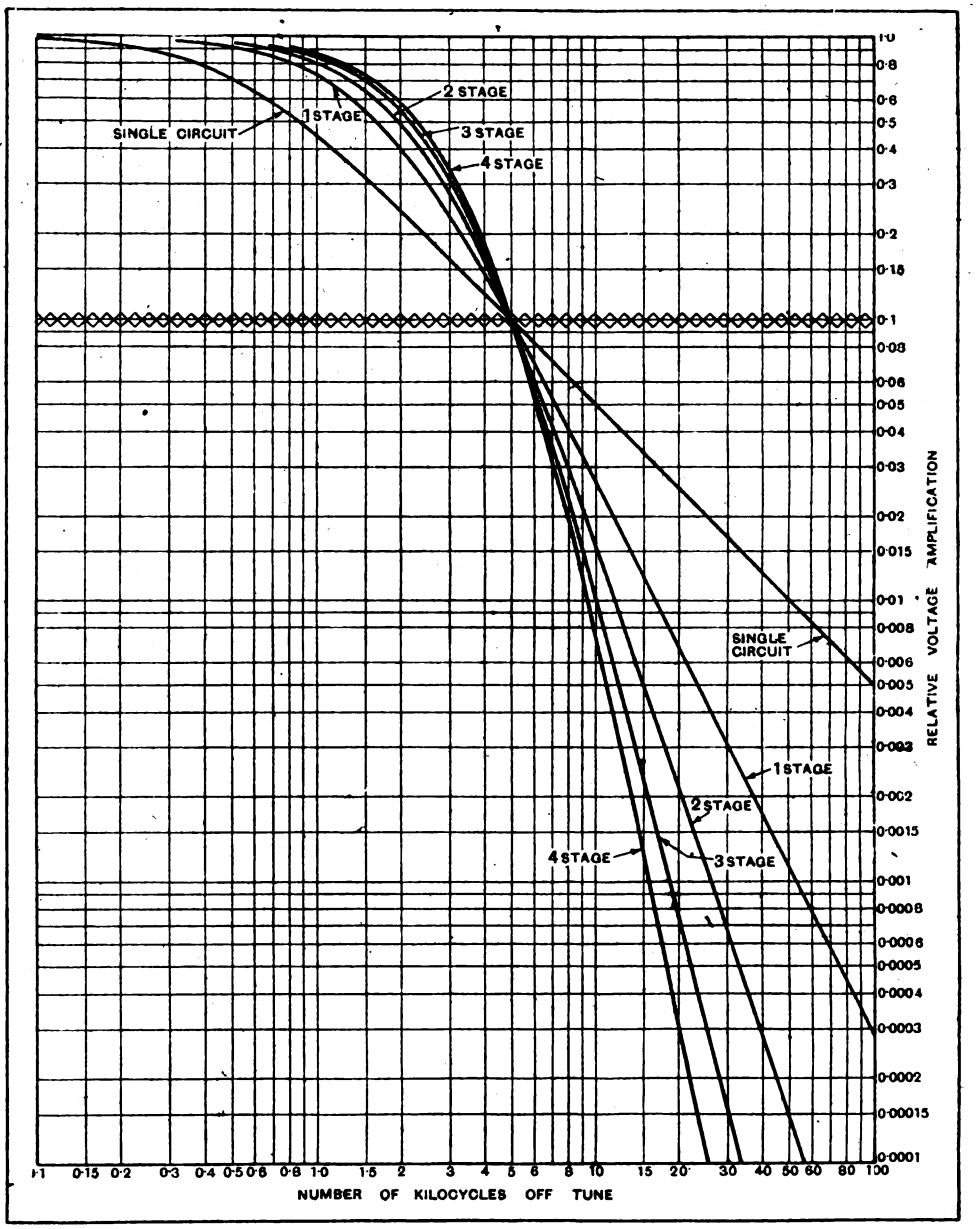

Fig. 3—Resonance curves plotted on a logarithmic scale. The shape of each curve is unaffected by changes in the value of the coil magnification, which only varies its position on a horizontal axis.

Single-stage H.F. Amplifier.

The single-valve H.F. amplifier shown in Fig. 4 (*a*) with tuned grid and plate circuits is equivalent to the scheme in Fig. 4 (*b*) where the equivalent grid circuit contains a series resistance R_1, including the aerial load, and the equivalent plate circuit contains a resistance R_2, including the load due to the valve resistance.

The resonance curve depends only on the coil magnifications of these two equivalent circuits, i.e., $m_1 = 2\pi L_1 f/R_1$ and $m_2 = 2\pi L_2 f/R_2$, and, to a high degree of approximation, it depends only on the product $m_1 m_2$, provided that m_1 does not exceed twice m_2, or vice versa.

[1] It should be noted that the resonance curves of Fig. 3 are reliable only up to an amount of detuning not exceeding 10% of the carrier frequency, and so in the example above, although the intersection can be displaced to 500 kc., the useful part of the displaced curve only extends to 100 kc.

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Selectivity in Plain Terms.—

Thus if we draw the resonance curve for an amplifier whose equivalent grid and plate circuits have $m_1 = m_2 = 100$, then a different amplifier with $m_1 = 71$, $m_2 = 140$, will give practically the same resonance curve, since in both cases $m_1 m_2 = 10{,}000$.

The resonance curve for one stage is given in Fig. 3 and, as in the case of a single circuit, its shape is invariable: it slides right or left as the product $m_1 m_2$ changes.

The selectivity number is $0.2 \times 3.33 \times \sqrt{m_1 m_2}$ as proved in the appendix: thus if the coil magnifications are 225 and 400, the selectivity number is 200, and with a carrier wave of 1,000 kc. the resonance curve cuts the cross-hatched line at 1,000/200 = 5 kc., as it actually does in Fig. 3.

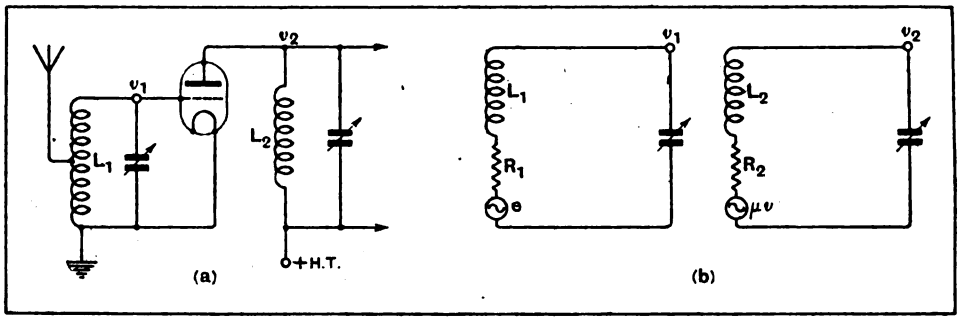

Fig. 4—Single-stage H.F. amplifier and equivalent H.F. circuits.

Multi-stage H.F. Amplifier.

Similar reasoning can be applied to H.F. amplifiers with more than one stage, and the results are given in the following table.

	Selectivity Number.
Crystal Circuit	$0.2 \times 1 \times m$
1 stage H.F.	$0.2 \times 3.33 \times [m_1 m_2]^{\frac{1}{2}}$
2 stages H.F.	$0.2 \times 5.24 \times [m_1 m_2 m_3]^{\frac{1}{3}}$
3 stages H.F.	$0.2 \times 6.80 \times [m_1 m_2 m_3 m_4]^{\frac{1}{4}}$
4 stages H.F.	$0.2 \times 8.13 \times [m_1 m_2 m_3 m_4 m_5]^{\frac{1}{5}}$

In this table a column of figures occurs which can be replaced by the consecutive odd numbers, 1, 3, 5, 7, 9, with an error not exceeding 11 per cent., and this circumstance allows us to formulate a simple rule for calculating the selectivity number.

Add the number of H.F. valves to the number of H.F. tuned circuits and multiply this sum by 0.2 *times the geometric mean product of the coil magnifications. The result is the selectivity number.*

This statement, in conjunction with the preceding italicised statement, may be taken as a summary of this article.

Uses of the Selectivity Number.

Let us take as an example a set with two H.F. screen valves, followed by an anode bend detector, an outside aerial being used. If the tuning coils are wound with solid wire on 2½in. formers and squeezed rather tightly into the screening boxes, the coil magnifications of the equivalent tuned circuits will be about 50 for the aerial circuit, and 100 for each of the tuned anode circuits.

The geometric mean product of these figures is $[50 \times 100 \times 100]^{\frac{1}{3}} = 100[0.5 \times 1 \times 1]^{\frac{1}{3}} = 80$ (approx.).

Hence the selectivity number is $5 \times 0.2 \times 80 = 80$.

When the set is tuned to a 1,600 kc. station the two-stage resonance curve in Fig. 3 must be displaced sideways till it intersects the cross-hatched line at 1,600/80 = 20 kc.

What about the quality of reproduction of this set? Inspection of the displaced curve shows that the relative voltage amplification at 10 kc. is 0.37, and 0.72 at 5 kc. Evidently the sidebands come through quite well, and the quality should be excellent.

Again if two stations 20 kc. apart are of equal strength at the receiver, one of them can be reduced to 0.1 of the strength of the other at the grid of the detector valve. This reduction is just sufficient to swamp the unwanted station.

If the stations are 47 kc. apart, one of them can be cut down to 0.01: hence even if it were originally ten times as strong as the other it can be swamped.

The same set made up with stranded wire coils in roomy screening boxes and provided with a frame aerial might have the coil magnifications somewhere about the values $m_1 = 250$, $m_2 = 200$, $m_3 = 200$. The geometric mean of these is $200[1.25 \times 1 \times 1]^{\frac{1}{3}} = 216$.

Hence the selectivity number is $5 \times 0.2 \times 216 = 216$, and when the set is tuned to a 1,080 kc. station the intersection occurs at 1,080/216 = 5 kc. This is the position of the two-stage curve in Fig. 3.

The sidebands in this case are cut down drastically, and the reproduction is barely tolerable: the separation of stations, however, is good. If two stations are 56 kc. apart, one of them can be cut down to 0.0001 relative to the other, so that even if it were 1,000 times as strong as the other at the receiver it could be cut out.

Since the curves in Fig. 3 have a common point of intersection they refer to sets which have the same selectivity number, namely, (station kc.)/5, which may be taken as the limit of tolerable reproduction.

Tolerable reproduction is given by (station kc.)/10, and good reproduction by (station kc.)/20.

It should be possible for manufacturers to guarantee the selectivity numbers of their sets, and it is quite possible for amateurs to calculate the selectivity number before a set is constructed. All that is required is the coil magnification, i.e., the ratio of coil reactance to coil resistance, of each coil which forms part of a tuned circuit, taking into account the loading due to the aerial in the case of the first coil and that due to the preceding valve in the case of each subsequent coil.

These data are well known, and only require setting out in tabular form to be immediately useful to readers.

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Selectivity in Plain Terms.—

One striking result follows from Fig. 3. Among a number of sets having equal selectivity numbers, and therefore intersecting the cross-hatched line at the same point, the set having the greatest number of tuned circuits gives the best reproduction and gives the sharpest separation of adjacent stations.

Several poor coils give better results than a few good ones. It may be that the realisation of high selectivity combined with good quality is to be found in the employment of a large number of H.F. stages with interstage H.F. transformers with a high step-up ratio to ensure stability.

Appendix.

The height of the resonance curve (Fig. 2) corresponding to a single tuned circuit (Fig. 1) is given by the expression

$$1/[1+4m^2.\delta f^2/f^2]^{\frac{1}{2}},$$

where m = coil magnification,

δf = number of kilocycles off tune,

f = frequency of carrier wave in kilocycles.

This expression is equal to 0.1 when $m.\delta f/f = 5$.

Hence at this point on the curve $f/\delta f = 0.2 \times m$, and this is defined as the selectivity number.

For two tuned circuits (single-stage H.F. amplifier) the expression is

$$1/[1+4m_1^2.\delta f^2/f^2]^{\frac{1}{2}}[1+4m_2^2.\delta f^2/f^2]^{\frac{1}{2}}$$

where m_1 m_2 are the coil magnifications.

This expression is equal to 0.1 when $[m_1m_2]^{\frac{1}{2}}.\delta f/f = 1.5$ to within a few per cent., provided that neither m is more than double the other.

Hence the selectivity number $= f/\delta f = 0.2 \times 3.33 \times [m_1m_2]^{\frac{1}{2}}$.

Similar results can be worked out for multi-stage H.F. amplifiers, and the results are given in the preceding table.

MANCHESTER RADIO SHOW

Guide to the Stands.

THE Home Secretary, the Rt. Hon. J. H. Clynes, will to-day open the sixth Manchester Wireless Exhibition, to be held in the City Hall under the auspices of the *Manchester Evening Chronicle*. Unlike its immediate forerunner at Olympia, the Manchester Show is not limited to manufacturers of any particular trade organisation, with the result that the City Hall contains many exhibits which were not shown in London, including apparatus of foreign manufacture. There will be altogether about 170 exhibitors, an increase of forty over last year, and this has necessitated some important structural additions which provide an additional 2,000 square feet of floor space.

As in previous years, visitors will be able to hear various types of loud speakers working from a common amplifier constructed by Messrs. Ferranti, Ltd. An innovation this year is the provision of a number of soundproof cubicles to enable manufacturers to demonstrate their products without interruption.

Of special interest to amateur constructors will be the public tests of home-made apparatus entered for set building competitions.

The Exhibition will remain open until Saturday, October 26th.

ADLEY RADIO, LTD., (91)
99, Mortimer St., London, W.1.

Æonic Radio, Ltd., (87)
90, Regent St., London, W.1.

Atalanta, (122G.)
1-3, Brixton Rd., London, S.W.9.

BAKER'S "SELHURST" RADIO, (111G.)
89, Selhurst Rd., South Norwood, London, S.E.25.

Beardsall & Co., Ltd., W. E., (2)
3-5, Victoria Bridge, Manchester.

Belling & Lee, Ltd., (7)
Queensway Works, Ponders End, Middlesex.

British Ebonite Co., Ltd., (15)
Nightingale Rd., Hanwell, London, W.7.

Brown Bros., Ltd., (56)
265, Deansgate, Manchester.

Brown, Ltd., S. G., (40)
Western Avenue, North Acton, London, W.3.

Brownie Wireless Co. of Great Britain, Ltd., (38)
Nelson St. Works, Mornington Crescent, London, N.W.1.

Burndept Wireless (1928), Ltd., (17)
Eastnor House, Blackheath, London, S.E.3.

Bush House Radio, (90)
23, Corporation St., Manchester.
35, Shudehill, Manchester.
40, Deansgate, Manchester.

CELESTION, LTD., (42)
London Road, Kingston-on-Thames.

Chloride Electrical Storage Co., Ltd. (Exide), (29)
Clifton Junction, nr. Manchester.

Clarke & Co. (M/c), Ltd., H., (41)
Atlas Works, Old Trafford, Manchester.

Climax Radio Electric, Ltd., (20)
Haverstock Works, Parkhill Rd., Hampstead, London, N.W.3.

Cole, Ltd., E. K., (25)
Ekco Works, London Rd., Leigh-on-Sea.

Continuous Gramophones, Ltd., (72)
Continuous Works, Hoe St., Walthamstow, London, E.17.

Coranto Cabinet Co., (60)
122, Leaf St., Stretford Rd., Manchester.

Cossor, Ltd., A. C., (76 & 77)
Cossor House, Highbury Grove, London, N.5.

Crossley & Son, Ltd., Geo., (89)
4, South St., Manchester.

DUBILIER CONDENSER CO. (1925), LTD., (33)
Ducon Works, Victoria Rd., North Acton, London, W.3.

Dulcetto Polyphon, Ltd., (92)
2-3, Newman St., London, W.1.

Dunderdale, Frank (Incorporating Wellworth Wireless Electrical Co.), (65)
8, Withy Grove, Manchester.

Dunhams, Ltd., (128)
Elm Works, Elm Park, Brixton Hill, London, S.W.2.

EASTICK & SONS, J. J., (101)
Eclex House, 118, Bunhill Row, London, E.C.1.

Edison Swan Electric Co., Ltd. (27 & 28)
123-125, Queen Victoria St., London, E.C.4 (Metro-Vick Supplies, Ltd., Trafford Park, Manchester, and British Thomson-Houston Co., Ltd., Rugby.) Manchester office: King's House, King's St. West.

Empire Electric Co., (129)
10, Fitzroy Sq., London, W.1.

Epoch Radio Manufacturing Co., Ltd., (103)
3, Farringdon Av., London, E.C.4.

Ever Ready Co. (Gt. Britain), Ltd., (18)
Hercules Place, Holloway, London, N.7.

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Manchester Radio Show.—

"Experimental Wireless," Iliffe & Sons Ltd., (34)
Dorset House, Tudor St., London, E.C.4.

FERRANTI, LTD., (52, 53 & 115)
Hollinwood, Lancs.

Fiddian, Bawtree & Co., (124)
Gem Works, Oakhill Rd., Sutton, Surrey.

Fonteyn & Co., Ltd., (130)
2, 4, 5, 6, Blandford Mews, Baker St., London, W.1.

Formo Co. (Arthur Preen & Co., Ltd.), (23)
Crown Works, Cricklewood Lane, London, N.W.2.

Fuller Accumulator Co. (1926), Ltd., (93)
Woodland Works, Chadwell Heath, Essex.

GARNETT, WHITELEY & CO., LTD., (31)
Broadgreen Rd., Liverpool.

The General Electric Co., Ltd., (48)
Magnet House, Victoria Bridge, Manchester.

Gilman, J. S., (113)
63, Basinghall St., London, E.C.2.

Goodmans, (84)
27, Farringdon St., London, E.C.4.

Graham-Amplion, Ltd., (32)
Slough, Bucks. Sales Offices: 25-25, Savile Row, London, W.1.

Gramo-Radio, Ltd., (93)
Commercial Works, Church, Accrington.

HALCYON WIRELESS CO., LTD., (26)
313, Regent St., London, W.1.

Hardman & Co., Ltd., (49)
The Baum, Rochdale.

Harlie Bros., (114)
Balham Rd., Lower Edmonton, London, N.9.

Hart Bros. Electrical Manufacturing Co., Ltd., (64)
4, Queensway, Ponders End, Mddx.

Haw & Co., Ltd., (105)
20, Cheapside, London, E.C.2.

Hollingdrake & Son, Ltd., Henry, (59)
65, Princes St., Stockport.

Holzman, Louis, (57)
37, Newman St., London, W.1.

Houghton-Butcher (Gt. Britain), Ltd., (82)
Manchester Depot: 170, Deansgate, Manchester. Head Office: 88-89, High Holborn, London, W.C.1.

IGRANIC ELECTRIC CO., LTD., (50)
147, Queen Victoria St., London, E.C.4.

Impex Electrical, Ltd., (107)
538, High Rd., Leytonstone, London, E.11.

JUNIT MANUFACTURING CO., LTD., (70)
2, Ravenscourt Sq., London, W.6.

KALISKY (ALDGATE), LTD., S., (68)
75, Aldgate High St., London, E.1.

Kolster-Brandes, Ltd., (74)
Cray Works, Sidcup, Kent.

LECTRO-LINX, LTD., (112)
254, Vauxhall Bridge Rd., Westminster, London, S.W.1.

Lissen, Ltd., (13 & 13A)
Lissenium Works, Friars Lane, Richmond, Surrey, and at Worple Rd., Isleworth, Middlesex.

London Radio Mfg. Co., Ltd., (6)
Trafalgar Works, Station Road, Merton Abbey, London, S.W.19.

Lyons, Ltd., Claude, (95)
76, Old Hall St., Liverpool.

M.P.A. WIRELESS, LTD., (21 & 22)
High Rd., Chiswick, London, W.4. Showrooms: 62, Conduit St., London, W.1.

Marconiphone Co., Ltd., (39)
210-212, Tottenham Court Rd., London, W.1.

McMichael, Ltd., L., (54)
Wexham Rd., Slough, Bucks.

M-L Magneto Syndicate, Ltd., (126)
Victoria Works, Coventry.

Moores & Co., J., (8)
Ravald St. Works, Salford.

Mullard Radio Valve Co., Ltd., (46 & 47)
Nightingale Works, Nightingale Lane, Balham, London, S.W.12.

NEW LONDON ELECTRON WORKS, LTD., (80)
East Ham, London, E.6.

Northern Steel & Hardware Co., Ltd., (104)
1-3, Southgate, Deansgate, Manchester.

OLDHAM & SON, LTD., (43)
Denton, Manchester.

Ormond Engineering Co., Ltd., (66)
Ormond House, Rosebery Av., London, E.C.1.

PARTRIDGE, WILSON & CO., (36)
Offices and Stores: 217a, Loughborough Rd., Leicester. Works: Linford St., Leicester.

Pertrix, Ltd., (37)
Britannia House, 233, Shaftesbury Av., London, W.C.2.

Peto-Scott Co., Ltd., (45)
77, City Rd., London, E.C.1.

Philips Lamps, Ltd., (19)
Philips House, 145, Charing Cross Road, London, W.C.2.

Philipson & Co., Ltd., (123)
Astley Bridge, Bolton.

Potter & Co., Ltd., H. B., (62)
Station Buildings, Rochdale.

Pye Radio, Ltd., (51)
Radio Works, Cambridge.

RADIOVIM, LTD., (94)
Sandford St., Ancoats, Manchester.
24, The Elms, Dingle, Liverpool.

Rawson, H. C. (Sheffield & London), Ltd. (30)
100, London Rd., Sheffield.

Redfern's Rubber Works, Ltd., (24)
Hyde, Cheshire.

Rees Mace Manufacturing Co., Ltd., (61)
59a, Welbeck St., London, W.1.

Rialton Radio, (117)
21a, Barbican, London, E.C.1.

Richardsons, (97)
24, St. John St., Deansgate, Manchester.

Ridged Cone Co., Ltd., (96)
York House, Southampton Row, London, W.C.1.

Ritherdon & Co., Ltd., (108 & 109)
Bolton.

Royal Radio Co., (86)
Dorset Mews North, Upper Gloucester Place, London, N.W.1.

Runbaken Magneto Co., (127)
Tipping St., Ardwick, Manchester.

SCOTT & CO., LTD., G. L., (102)
Morris House, 60-66, Rochester Row, London, S.W.1.

Selectors, Ltd., (9)
206-207, Bedford Av., Slough Trading Estate, Slough, Bucks.

Siemens Bros. & Co., Ltd., (81)
Woolwich, London, S.E.18.

Sifam Electrical Instrument Co., Ltd., (11)
Bush House, Aldwych, London, W.C.2.

Six-Sixty Radio Co., (55)
122, Charing Cross Road, London, W.C.2.

Squire, F., (116)
24, Leswin Rd., Stoke Newington, London, N.16.

Standard Insulator Co., Ltd., (71)
Winsley House, Wells St., Oxford St., London, W.1.

Standard Wet Battery Co., (63)
184-188, Shaftesbury Av., London, W.C.2.

Stott, J. E., (125)
15, Clare Hill, Huddersfield.

TELEGRAPH CONDENSER CO., LTD., (83)
Wales Farm Rd., North Acton, London, W.3.

Telsen Electric Co., Ltd., (75)
Miller St., Birmingham.

Truphonic Radio, Ltd., (35)
Truphonic House, Hanover Park, Peckham, London, S.E.

Tungsram Electric Lamp Works (Great Britain), Ltd., (10)
72, Oxford St., London, W.1.

Tutills, Ltd., (14)
7-9, Swan St., Manchester.

UNIVERSAL GRAMOPHONE & RADIO CO., LTD., (88)
Kentish Town, London, N.W.5.

VANDERVELL & CO., LTD., (44)
C. A.,
Wornle Way, Acton, London, W.3.

Varley (Oliver Pell Control, Ltd.), (58)
Kingsway House, 103, Kingsway, London, W.C.2.

WARD & GOLDSTONE, LTD., (16)
Frederick Rd., Pendleton, Manchester.

Watmel Wireless Co., Ltd., (5)
High St., Edgware, Middlesex.

Westinghouse Brake & Saxby Signal Co., Ltd., (73)
32, York Rd., King's Cross, London, N.1.

Whiteley, Boneham & Co., Ltd., (7)
Nottingham Rd., Mansfield, Notts.

"The Wireless World," Iliffe & Sons Ltd., (54)
Dorset House, Tudor St., London, E.C.4.

Wright & Weaire, Ltd., (69)
740, High Rd., Tottenham, London, N.17

YAGERPHONE, LTD., (65)
28, Charlotte St., London, E.C.2.

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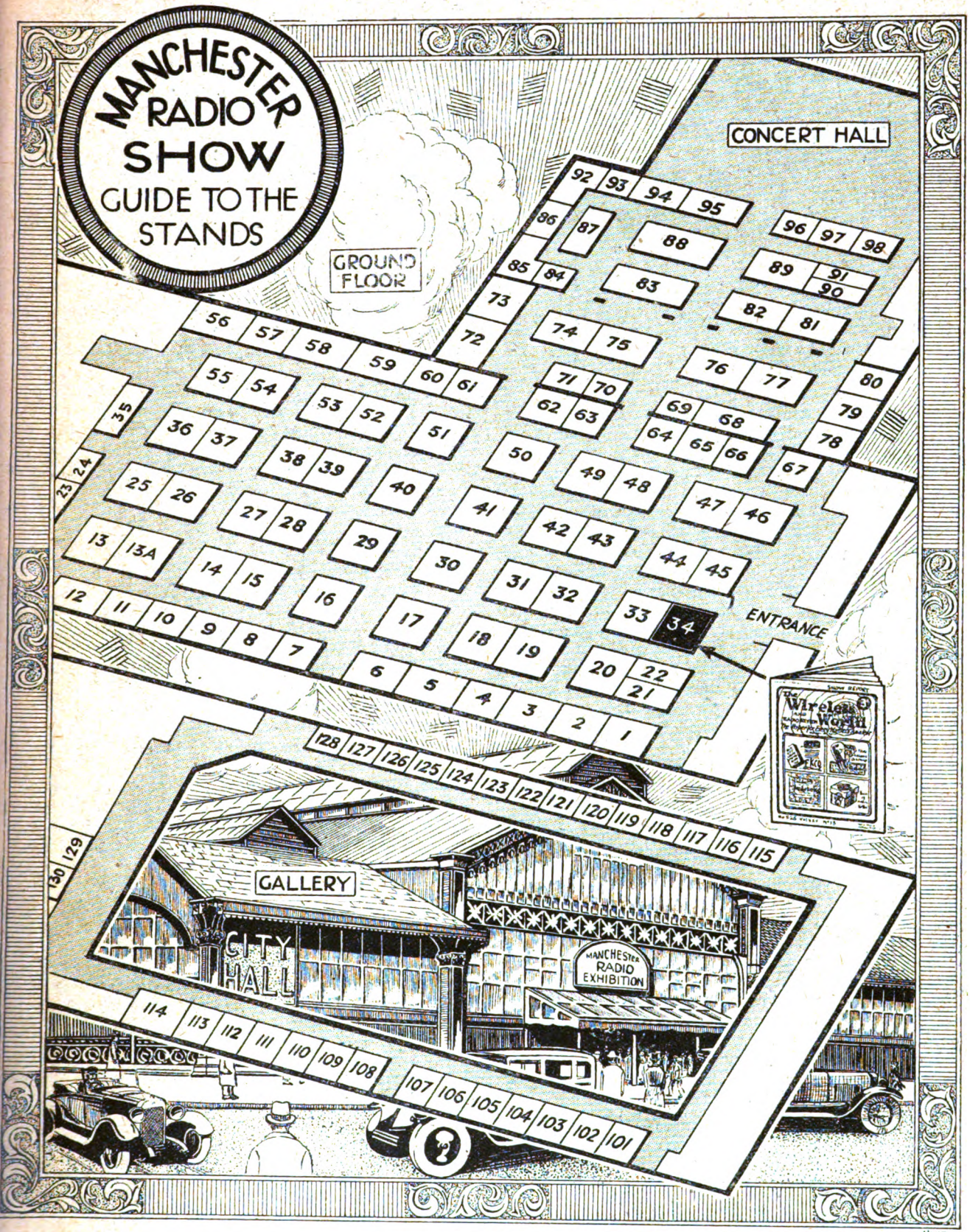

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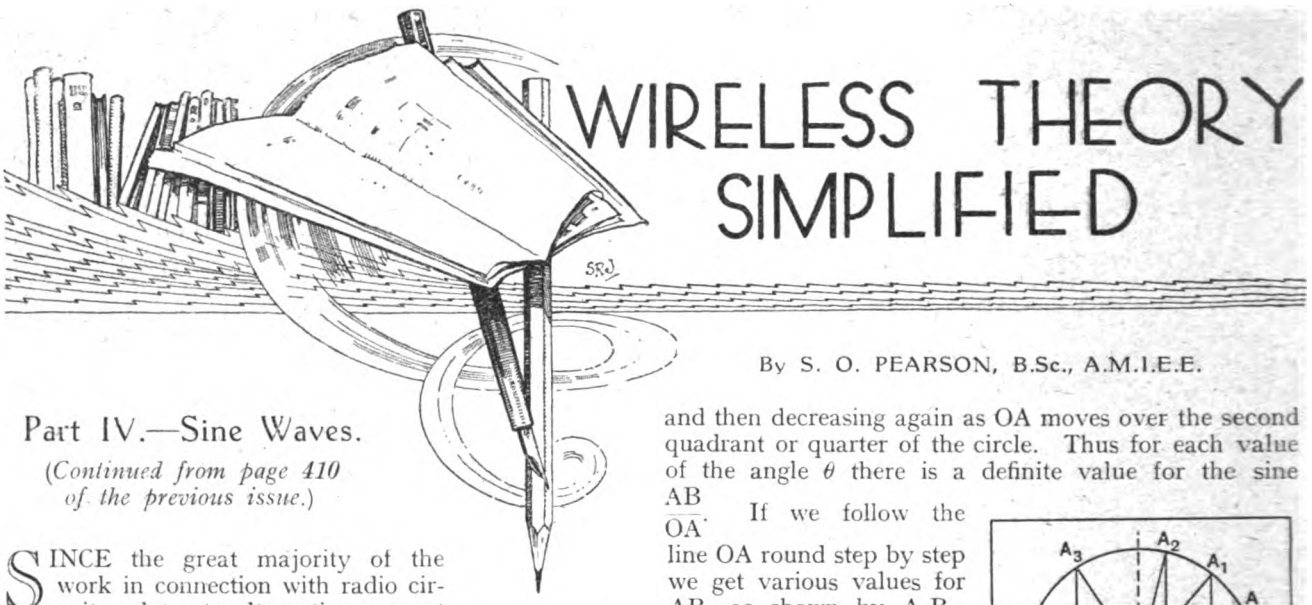

WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

Part IV.—Sine Waves.

(*Continued from page 410 of the previous issue.*)

SINCE the great majority of the work in connection with radio circuits relates to alternating current phenomena we shall have a good deal to do with sine waves. It would be a very tedious process if we had actually to draw one or more sine waves every time we had a calculation to make, and fortunately this is not necessary. A sine wave of current or voltage can be represented by a simple straight line, and the method of doing this is explained below.

So far we have referred to a sine wave without giving any explanation as to its nature or how it can be drawn. The term "sine" is simply the name given to the ratio of two sides of a right-angled triangle. For instance, in Fig. 1 we have a right-angled triangle OAB in which the angle at O is denoted by θ (Greek letter "theta"); the ratio of AB to OA is the sine of θ or $\sin\theta$. The sine of θ is the side opposite to the angle θ divided by the side opposite to the right angle. In any right-angled triangle the side opposite to the right angle is the longest, so that the sine of an angle can never be greater than 1. When θ is made nearly equal to 90°, OB becomes very short, and AB becomes very nearly equal to OA, and the sine becomes nearly equal to unity. The sine of 90° is actually equal to 1.

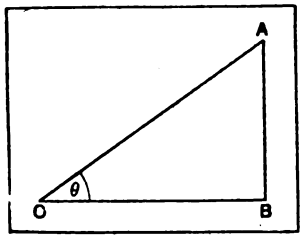

Fig. 1.—In the right-angled triangle OAB the sine of the angle θ is $\frac{AB}{OA}$.

Now suppose that the side OA is of constant length and is slowly rotated about the end O in the opposite direction to that of the hands of a clock, i.e., anti-clockwise, so that the end A moves in a circle as shown in Fig. 2, the other two sides OB and AB remaining horizontal and vertical respectively. It will be seen that the angle θ gets larger as the line OA pivots round and at the same time the length of the line AB is changing, increasing at first until OA becomes vertical, and then decreasing again as OA moves over the second quadrant or quarter of the circle. Thus for each value of the angle θ there is a definite value for the sine $\frac{AB}{OA}$. If we follow the line OA round step by step we get various values for AB, as shown by A_1B_1, A_2B_2, A_3B_3, etc., in the diagram. If the rotating line OA is made one inch long, the lengths in inches of A_1B_1, A_2B_2, etc., give the values of the sines of the corresponding angles. The sine reaches its maximum value when OA becomes vertical, being equal to 1, and begins to diminish again as OA passes through the second quarter of the circle. In the third and fourth quadrants AB falls below the horizontal line, and the sine has a negative value.

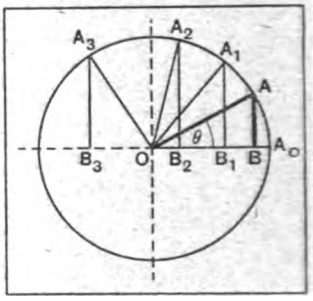

Fig. 2.—If the side OA of the right-angled triangle of Fig. 1 is rotated about O whilst the other two sides keep their original directions, the relationship between θ and $\sin\theta$ can be found for all values of θ.

The connection between a rotating straight line or *rotating vector*, such as OA of Fig. 2 and a sine wave, is shown in the construction of Fig. 3. A circle is drawn and its circumference divided into, say, sixteen

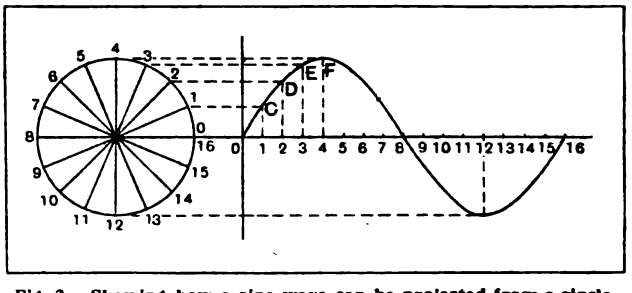

Fig. 3.—Showing how a sine wave can be projected from a circle. Both the circumference of the circle and the base line are divided into 16 equal parts.

equal parts, the sixteen radial lines representing the successive positions of the rotating line or vector. A horizontal line is then drawn through the centre of the circle and extended to the right. Starting from O,

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Wireless Theory Simplified.—

sixteen equal divisions are measured off along this line and numbered as shown. If now a horizontal line through 1 on the circle is drawn to cut the vertical line through division 1 on the base line, the point of intersection, shown at C, gives a point on the sine wave being constructed. By proceeding in this way with the remainder of the corresponding pairs of numbers we obtain the points D, E, F, etc., which enable the sine wave to be traced.

Explaining the R.M.S. Value.

There are two things to be noticed regarding the relationship between the rotating vector and the sine curve constructed from it: (*a*) the maximum height of the sine curve is equal to the radius of the circle or the length of the vector; (*b*) one complete revolution of the vector corresponds to one complete sine wave—one positive and one negative half wave.

We have seen how a sine wave can be obtained from a straight line rotating about one end, and therefore if we have a sine wave to consider showing the relationship between any quantity and time, we can represent it by a straight line rotating continuously about one end with constant speed. For instance, if we have an alternating current whose maximum value is 10 amps. and whose frequency is 50 cycles per second, we can represent it by a straight line 10 cms. long rotating about

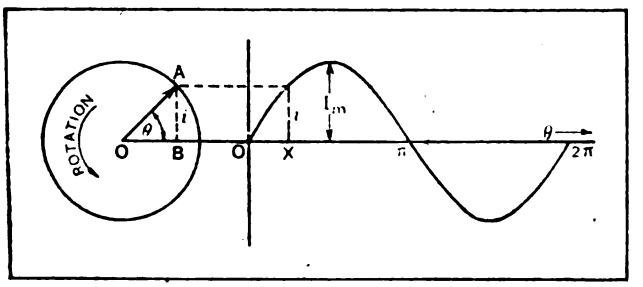

Fig. 4.—Showing how a sine wave of current can be represented by a rotating straight line OA.

one end at a speed of fifty revolutions per second. Actually on paper we draw it in one only of the positions which it is bound to pass through, and have to imagine the rotation—not a very difficult feat.

On the right-hand side of Fig. 4 is a sine wave of current whose maximum value or amplitude is I_m amperes. The rotating vector OA representing it is made equal in length to I_m to the same scale as that to which the wave is drawn. If the frequency of the current is f cycles per second, the vector is assumed to be rotating at a speed of f revolutions per second about one end. At the instant indicated by X, the current has a value of $i = AB$ amperes. But $\frac{AB}{OA} = \frac{i}{I_m} = \sin\theta$. Therefore, $i = I_m \sin\theta$, or, in other words, the current is varying according to a sine law with respect to the angle θ, which is increasing continuously with time.

It will be noticed how very frequently the number 2π is met with in alternating current work. It is a very important number, and our simple rotating vector enables us to see exactly how it originates. The circumference of a circle is 3.1416 times as long as the diameter, and this number is denoted by π (Greek letter "Pi"). Thus the circumference is 2π times the radius. Now if we mark off on the circumference of a circle a length PQ equal to the radius as in Fig. 5, the angle POQ subtended at the centre is called *one radian*, and there are obviously 2π radians in a complete circle of 360 degrees. Referring again to Fig. 4, the constantly increasing angle θ which the vector OA makes with the horizontal line is measured in radians, and in order that the base of the sine wave shall correspond this is scaled to represent the angle passed through by the vector instead of the time in seconds. Since the angle is exactly proportional to time it simply involves a different scale; in other words, the wave is plotted to an angle base instead of a time base as previously. Since one complete wave is represented by one complete revolution of the vector it follows that the base line of one complete wave corresponds to 2π radians.

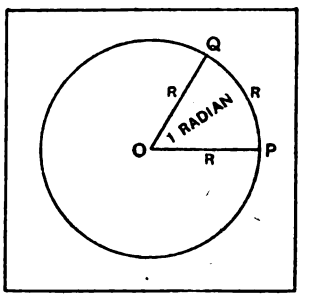

Fig. 5.—When PQ is equal to the radius of the circle the angle QOP is one radian.

It was stated that when the frequency is f cycles per second the rotating vector makes f revolutions per second, and the vector therefore passes through $2\pi f$ radians every second. Thus in t seconds after passing through the starting position the angle θ will be $2\pi ft$ radians, and therefore at any time t the value of the current is given $i = I_m \sin 2\pi ft$ amps., where I_m is the maximum value, the effective or R.M.S. value being $0.707 I_m$.

Two Alternating Currents in Phase.

Two sine waves of equal frequency are said to be *in phase* if they are exactly in step, i.e., if they both pass

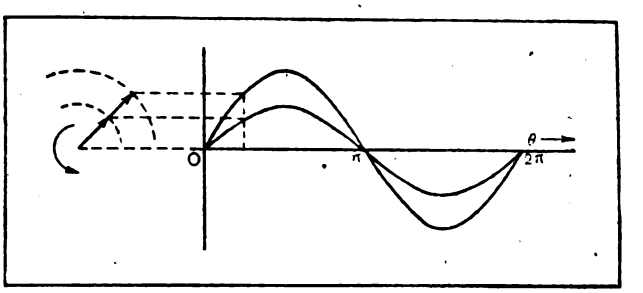

Fig. 6.—Two sine waves in phase with each other. The diagram shows that the vectors representing the two waves coincide with one another.

through their maximum positive values at the same instant. Two waves in phase are shown by the sine curves of Fig. 6, the waves having different amplitudes. Since each reaches its maximum value at the same instant it follows that the respective vectors representing them must pass through the vertical position simul-

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Wireless Theory Simplified.—

taneously, and therefore must coincide with each other as shown on the left-hand side of the diagram. Their lengths may be simply added together to give the maximum value of the sum of the two currents.

Sine Waves Out of Phase.

It is only under special circumstances that we find sine waves exactly in phase in A.C. circuits. In the great majority of cases the two or more waves under consideration are out of step or *out of phase*. There is said to be a phase difference between them. In Fig. 7 are shown two sine waves which are out of step by exactly one quarter of a cycle—one of them passes through its zero value just as the other reaches its maximum value. It will be clear that the vector representing the one must be horizontal at the same instant as the vector representing the other is vertical, and so for two waves out of step by a quarter of a cycle, the respective vectors representing them are mutually at right angles. For this reason the two waves are said to be out of phase by an angle of 90°. Note that curve (1) reaches its maximum value before curve (2), and so curve (2)

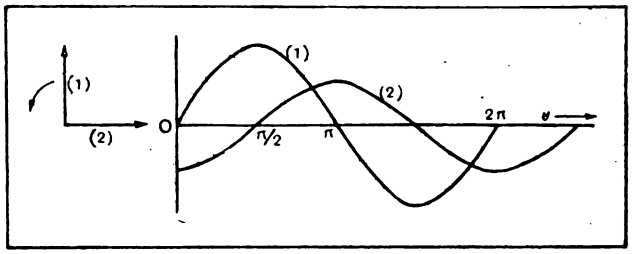

Fig. 7.—Showing two sine waves 90° out of phase. The vectors representing them are mutually at right angles.

is said to *lag behind* curve (1) by an angle of 90°. Also since the vectors are assumed to be rotating anti-clockwise, vector (2) is shown lagging behind vector (1) by 90°.

Adding Currents which are Out of Phase.

Suppose that we have two alternating currents I_1 and I_2 out of phase by 90°, and that we require to add them together to find the resultant current. They cannot be added numerically because they are out of step. Draw the two vectors OI_1 and OI_2 representing them, mutually at right angles as shown in Fig. 8. Complete the rectangle OI_1 II_2. The diagonal OI gives the resultant both in magnitude and phase relationship to the others. This may be done to scale and OI measured, or by calculation, in which case the resultant current is given by $I = \sqrt{I_1^2 + I_2^2}$ amps.

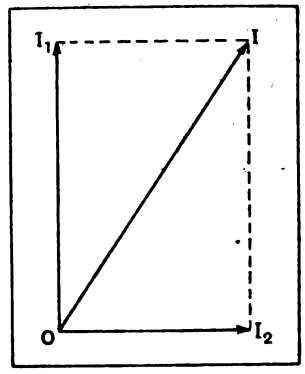

Fig. 8.—Showing how to add together two alternating currents which are out of step by a quarter of a cycle.

If the currents (or E.M.F.s) are out of phase by any other angle than 90° the same procedure is adopted, namely—draw the individual vectors to scale at the correct angle to each other, complete the parallelogram and measure the diagonal.

As an example, suppose that two alternating E.M.F.s of 100 volts and 50 volts respectively are out of phase by an angle of 60° and are connected in series. Draw two lines mutually at 60° as in Fig. 9, making one 10 cms. long and the other 5 cms., that is, to a scale of 1 cm. = 10 volts. Complete the parallelogram and measure the length of the diagonal which passes through the intersection of the original vectors at O. The length will be found to be about 13.2 cms., giving a resultant voltage of 132. The value could be calculated, but the process is more complicated.

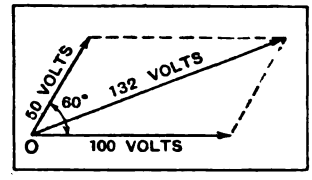

Fig. 9.—Addition of two voltages by the parallelogram method.

It is very important to remember that when adding up alternating currents or voltages the phase difference must always be taken into account by using the parallelogram method explained. Ordinary arithmetical addition does not give a true answer when the quantities to be added are out of step. (*To be continued.*)

CLUB NEWS.

Club Season Begins.

The return to G.M.T. has signalised the resumption of club activities all over the country. In the majority of cases programmes for the ensuing months have already been prepared, and it seems likely that the 1929-30 session will equal any of its predecessors in enthusiasm and useful work.

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A Seven-Year Record.

An apology is due to the Hackney and District Radio Society in respect of the paragraph in our issue of September 18th, in which it was stated that the Society had "resumed its meetings." To the Hackney and District Radio Society belongs the distinction of having maintained its activities throughout the summer months, and meetings have, in fact, been held every week for seven years. An attractive programme has been prepared for the winter months, and full particulars can be obtained on application to Mr. G. W. Heath, Assistant Hon. Secretary, 61, Lauriston Road, Hackney, E.9.

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Edinburgh Society's New Headquarters.

The Edinburgh and District Radio Society now has new headquarters at 16, Royal Terrace, and meetings will be held every Wednesday during the winter months at 8 p.m. Full particulars can be obtained from the Hon. Secretary, Mr. E. I. Robertson, 10, Richmond Terrace, Edinburgh.

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Institute of Wireless Technology.

The Annual General Meeting of the Institute of Wireless Technology was held on Wednesday last, October 9th, at the Engineers' Club, Coventry Street, London, W. All interested in the activities of the Institute are invited to communicate with the Hon. Secretary, at 71, Kingsway, London, W.C.2.

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Bringing Olympia to Birmingham.

Members of Slade Radio (Birmingham) who were unable to visit the Olympia Wireless Exhibition were specially catered for in an interesting summing-up of the Exhibition given by Mr. A. Freeman at a recent meeting. Demonstrations were given of various kinds of apparatus which were on view at Olympia.

The Society will hold its fourth Whist Drive and Dance on October 23rd. On October 24th a lecture on battery eliminators and mains receivers will be given by Mr. Ingham, of Messrs. Clarke and Co. (Manchester), Ltd. Details of these and other activities of the Society may be obtained from the Hon. Secretary, "Enville," Warren Road, Erdington.

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Newcastle-upon-Tyne Radio Society.

The Annual General Meeting of the Newcastle-upon-Tyne Radio Society was held in the English Lecture Room, Armstrong College, on October 7th, when the forthcoming lectures of the society were discussed.

Hon. Secretary, Mr. W. W. Pope, 7, Kimberley Gardens, Jesmond, Newcastle-upon-Tyne.

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Lectures for Beginners.

Weekly lectures specially for beginners are a feature of the syllabus at the Woolman Radio Society. Meetings are held every Friday at the John Woolman Settlement, 28, Duncan Terrace, London, N.1. Hon. Secretary, Mr. E. Dart, 86, Hampden Road, Hornsey, N.8.

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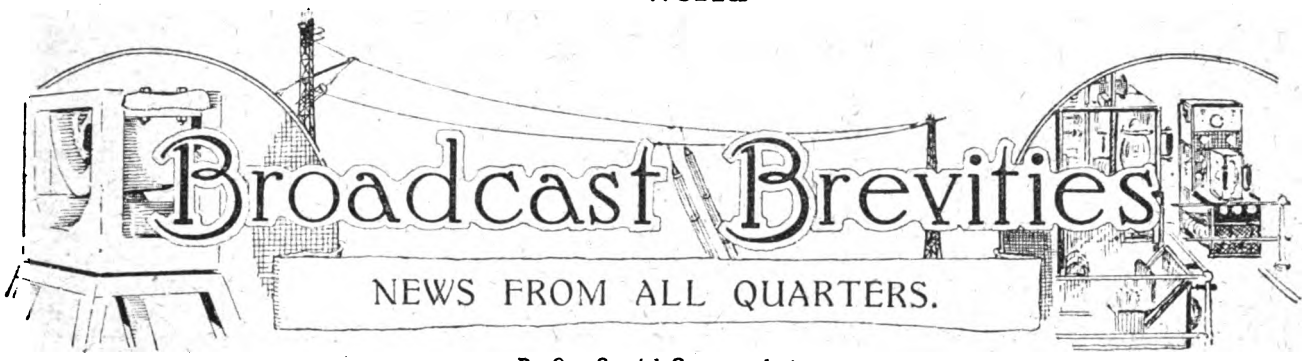

By Our Special Correspondent.

Transatlantic Relay Rivalry.—Prague Plan Fears.—5GB's Wavelength.

A Postponement.

For certain domestic reasons, the B.B.C. has decided that the high-power station at Brookman's Park shall not "take over" entirely from the Oxford Street transmitter until Monday next, October 21st, a week later than was originally announced.

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Free Transmitters for All.

From the Savoy Hill letter-bag :—

"I have a small crystal set and should like a Brookman transmitter, which on my wireless this evening you say is given free of charge."

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Satanic Interruptions.

Interference with the morning religious service from Daventry has been traced to the Devil's Point station (GYO), Plymouth.

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A Spaced-Aerial Triumph.

Although the solder on the receiving set had scarcely hardened, the new Tatsfield station of the B.B.C. played a distinguished part in the reception and relaying of the running commentary on the Prime Minister's arrival in New York. Two American short-wavers were picked up, viz., 2XAD (19.56 metres) and 2XK (17.34), which are both at Schenectady.

The Tatsfield station is not yet fully equipped (two of the short-wave receivers have still to be completed), and for this reason the relay was also undertaken by the spaced-aerial receiving plant at Tarling, near Chelmsford, so that both receivers sent signals to the Savoy Hill control room. I am told that the spaced-aerial method has recently been giving a good account of itself.

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Tarling *versus* Tatsfield.

It will be remembered that the idea of spacing aerials at intervals over several miles arose out of conversations between Captain Eckersley and Dr. Goldsmith, of the National Broadcasting Company of America, when Transatlantic relays were discussed two years ago. Then, to a greater extent than now, fading was the great obstacle to Transatlantic programmes, and it was with the object of obtaining constancy of aerial input that the experiment was tried of feeding one receiver from a number of widely separated aerials, which would not all be subjected to fading at the same moment.

The success of the latest relay shows that the experiment may justify the large expenditure necessary to erect such an elaborate system. But I have no doubt that Tatsfield, when once it is in full working order, will have something to say about this.

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Is the Prague Plan Good Enough?

Even if it failed as a Transatlantic relay station—and there is nothing to suggest such a possibility—the Tatsfield station would still be fully employed as the B.B.C.'s ether sleuth. More and more the B.B.C. engineers are coming to rely upon the periodical reports from the official receiving station regarding European transmitters which stray from their allotted frequencies under the Prague Plan. During the past fortnight heterodyne troubles have been growing all over Europe, and a significant feature is that in not every case is this due to departure from the allotted frequency.

Savoy Hill is beginning to fear that the separation of 9 kilocycles between transmitters is insufficient during the winter months.

FUTURE FEATURES.

London and Daventry.

OCTOBER 21ST.—"Point of View (4), by Mr. H. G. Wells.

OCTOBER 25TH.—Orchestral Concert from the Queen's Hall.

OCTOBER 26TH.—Old-time Vaudeville Programme.

Daventry Experimental (5GB).

OCTOBER 22ND.—"The Monkey's Paw," a story by W. W. Jacobs, dramatised by Louis N. Parker.

OCTOBER 24TH.—An Edward German Programme.

Cardiff.

OCTOBER 22ND.—"Sixty Years of Song," a programme in memory of Fred E. Weatherly.

Manchester.

OCTOBER 24TH.—A Musical Comedy Programme.

Glasgow.

OCTOBER 22ND.—A Jacobite Concert.

OCTOBER 26TH.—Running Commentary on Wales *v.* Scotland International Association Football Match.

Belfast.

OCTOBER 24TH.—"The Faithful Sentinel," an opera, music by Franz Schubert.

Another B.B.C. Pamphlet.

So many complaints have been received at headquarters regarding interference from Continental stations that the Technical Correspondence Department is seriously considering the preparation of yet another pamphlet, which will tell the listener all he wants to know about heterodyning, and probably a good deal more.

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New Wavelength for 5GB?

Owing to continued interference by Langenberg, it is rumoured that Daventry 5GB may shortly change its wavelength from 479.2 to 398.5 metres. Such a step would increase the troubles of southern listeners, who already experience difficulty in cutting out Brookman's Park when receiving the alternative programme, and it is to be hoped that 5GB's wavelength change will be deferred until the regional station is sending out twin transmissions.

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On Armistice Day.

The Cenotaph service will be relayed to listeners on Armistice Day, the transmission being almost exactly the same as last year. All B.B.C. stations will participate, including 5GB and 5SW.

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A Happy Ending.

An idea is prevalent that the majority of Russian plays are of an unhappy character; in contrast to that view, a play entitled "Michael," which 5GB listeners will hear on October 29, ends on a note of triumph.

"Michael" is a play in three scenes by Miles Malleson; it is an adaptation of Leo Tolstoy's tale, "What Men Live By." The incidental music is by Norman O'Neill.

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Running Commentary : New Style.

A change from the ordinary running commentary will be broadcast from 2LO, 5XX, throughout the Northern Region and from other stations on Saturday next, October 19 It will be a humorous description by L. T. Whipp, the Lancashire dialect entertainer, of the military band contest which is taking place on that day at Belle Vue, Manchester.

Following Mr. Whipp's efforts, a performance by the winning band will be broadcast.

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LABORATORY TESTS.

A Review of Manufacturers' Recent Products.

KESTER SOLDER.

Soldering and its indispensable partner, soldering paste, play an important part in the construction of a wireless set. This, however, is one only of the multitudinous uses to which it is put to-day. Many schemes to render soldering easy have been devised, and one of the latest is the Kester method. Kester radio solder consists of a hollow tube of genuine tin and lead filled with a non-corrosive rosin flux, and can be used to solder the most delicate wires with safety.

Kester rosin-core solder for wireless use. The illustration shows a 4-oz. tin.

This is sold in 4oz. tins at 1s. 6d. for set constructors' use, and in 1lb. spools, at 3s. 4d. per spool, for those requiring larger quantities.

An acid core solder for general domestic use, but not recommended for wireless purposes, is available in 1lb. spools at 3s. 4d. each.

Supplies can be obtained from the Rothermel Corporation, Ltd., 24 and 26, Maddox Street, Regent Street, London, W.1.

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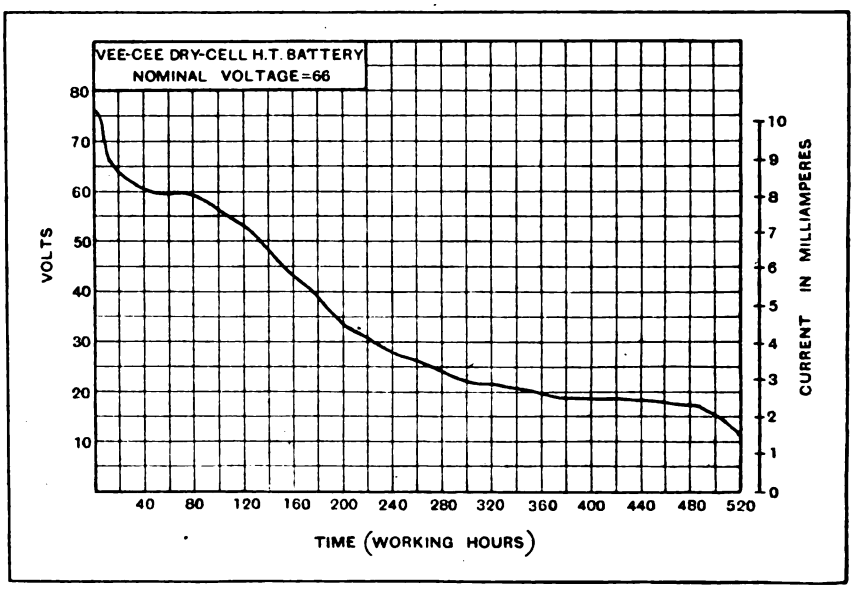
VEE-CEE DRY BATTERY.

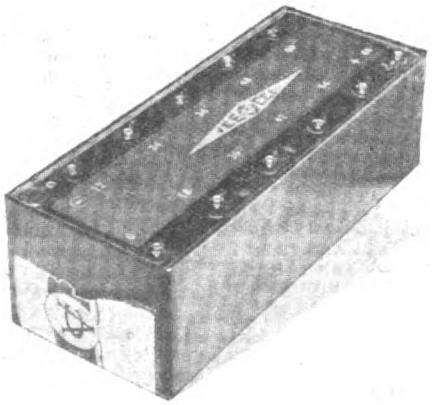
These batteries are made by the Vee-Cee Dry Cell Company (1927), Ltd., 5, Queensway, Ponders End, Middlesex. The sample submitted for test was a standard capacity size, rated at 66 volts, and sells at 7s. 6d. It was decided that about 8 mA would be the normal discharge rate of a battery of this size, so the discharge was commenced at just over 10 mA, which would assure a current of this order after the initial voltage drop.

The terminal voltage at the commencement of the test was 76 volts, but this fell rapidly during the first few hours and soon reached a more steady state at 60 volts. However, this was maintained for about 40 hours only, after which the voltage dropped steadily until the battery was exhausted. There was a slight recovery after 280 hours' discharge, and for the next 200 hours the voltage was maintained at a fair level. It would appear from an examination of the discharge curve that the initial current was on the high side for a battery of this size, and a better performance would have resulted if this had been reduced to between 6 and 8 mA.

The useful life of this particular battery at a discharge of the order of 8 mA would appear to be about 200 working hours, but this figure would be doubled, probably, by limiting the current taken to about 6 mA. Many other sizes of these batteries are available, all having the same capacity, however. A 108-volt size costs 12s. 6d., and the 120-volt model 14s. 6d. Grid batteries, 9 volt size, are marketed at 1s. 3d.



Discharge curve of the "Vee-Cee" 66-volt H.T. dry cell battery.



"Vee-Cee" dry cell battery; 66 volts nominal.

oooo

"TRIX" A.C. VALVE HOLDER.

This valve holder has been designed for the new 5-pin A.C. valves which have recently appeared on the market. It is of the rigid type and consists of a moulded base carrying five insulated pillars with brass insets. Four of these are spaced as in the familiar 4-pin type, the extra socket being placed in the centre. The valve holder is, therefore, of universal application, since it can be used with either the new or the old type of valve fitted with base pins.

The insulating sleeve on the anode socket is coloured red to distinguish it from the others; these are encased in black material. Five small terminals are fitted, four being marked, but the fifth, which connects with the centre socket, is not distinguished by any particular marking. The makers are Messrs. Eric J. Lever (Trix), Ltd., 8-9, Clerkenwell Green, London, E.C.1, and the price is 1s. 3d.

"Trix" A.C. valve holder for the new 5-pin A.C. valves.

Catalogues Received.

Messrs. Lissen, Ltd., Lissenium Works, Friars Lane, Richmond, Surrey.—Illustrated folders dealing with radio-gramophone sets, portable receivers, the Lissenola three-valve cabinet receiver and new season Lissen components.

oooo

The Peto-Scott Co., Ltd., 77, City Road, London, E.C.1.—Illustrated catalogue of proprietary receivers available under the convenient purchase system arranged by this company.

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Messrs. Wright and Weaire, Ltd., 740, High Road, Tottenham, London, N.17.—Illustrated folder describing some new Wearite components.

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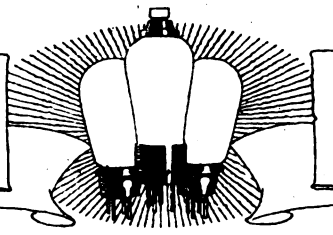
READERS' PROBLEMS.



"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Saving the Batteries.

In order to reduce the risk of leaving my set switched on all night I should like to fit a warning lamp; will you please tell me how it should be connected? The set is a commercial product, and I do not know its precise circuit arrangement, but imagine that it should be an easy matter to add the lamp. M. K. W.

The fitting of a lamp to indicate when the filaments are switched on is the simplest possible operation. Having obtained a lamp—a type having a low current consumption should be chosen—and a suitable holder, all you have to do is to wire it directly across the filament terminals of any convenient valve-holder in the receiver.

If your set has provision for gramophone reproduction arranged in such a way that the H.F. valve is automatically switched off, you must take the precaution of seeing that the lamp is operative when the gramophone pick-up is in use.

oooo

An Indoor Aerial Set.

Can you refer me to any published description of a receiver designed specifically for use with an indoor aerial? J. S. P.

It is correct to say that there is no basic difference between a receiver designed for working with a very short aerial and one intended for operation with a collector of the full 100ft. length allowed by the Post Office regulations.

Generally speaking, any of the sets described in this journal are suitable for short aerials; naturally, the more sensitive receivers give better results.

It may be added that where aperiodic aerial coupling or a separately tuned aerial is employed it is generally advised that the aerial connection should be made directly to the grid of the first H.F. valve.

oooo

Screening Unnecessary.

I am building a set on the lines of the "Kilo-Mag Four," but with two L.F. stages. Provided all the apparatus associated with the H.F. amplifier and the detector valve is adequately screened, will it be necessary to mount the L.F. portion in a metal box? C. N. A.

This precaution will be quite unnecessary if the H.F. component in the detector anode circuit is adequately disposed of, and if matters are so arranged that it cannot cause instability through interaction with the input end of the set.

oooo

An Extra Tuned Circuit for the "Everyman Four."

My set is an "Everyman Four" constructed in accordance with the instructions given in the revised booklet. With a view to increasing its selectivity still further, I should like to add a loose-coupled and separately tuned aerial circuit, which, it is noted, is included in a number of modern sets.

Will you please tell me if this scheme is practicable, and if so, give me a hint as to how I should proceed? A. C. P.

This set lends itself very readily to your proposed alteration; additions to the present wiring will be made clear, if you consider the circuit diagram given in Fig. 1.

The existing aerial connections on the primary of the aerial-grid transformer should be ignored, and an extra tapping will be made at approximately the second

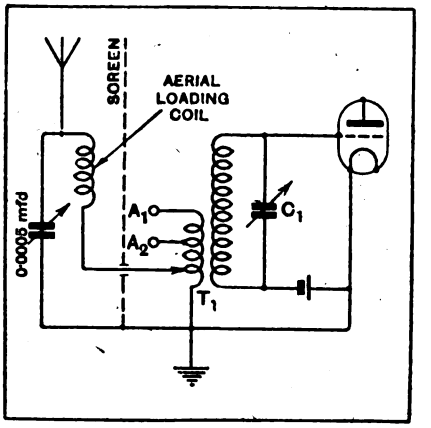


Fig. 1.—Aerial-grid circuit of the "Everyman Four" receiver modified by the addition of a separately tuned aerial.

turn from the earthed end of the primary. If the selectivity afforded by this connection is insufficient, it will be necessary to join the loaded aerial to a point still nearer the earthed end.

Needless to say, this extra circuit will not be operative on the long-wave band.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

Changing Conditions.

Although the selectivity of my "Megavox" receiver is quite adequate for present requirements, I anticipate that it will be necessary to improve it in this respect in the near future. Have you published any information dealing with this problem? T. M. S.

We think that we cannot do better than refer you to the "Readers' Problems" section of our issue for May 8th, where a modified arrangement of the aerial circuit of this receiver was suggested.

If you do not wish to make any internal alterations, we would suggest that you should study carefully the article on wave traps and absorption circuits which appeared in the issue of October 2nd.

oooo

Ample H.T. Voltage.

I have an H.T. eliminator with a rated maximum output of 120 volts. Would this be suitable for use with the "Record III" receiver? D. R. S.

Good results would be attainable with an H.T. pressure of about 120 volts, but the performance of the set would be considerably improved by increasing this up to, say, 150 volts. The published figures with regard to measured H.F. amplification were obtained with the full rated voltage applied to the H.F. valve anode

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Pick-up Connections for the "Foreign Listeners' Four."

Will you please tell me if it is possible to fit a pick-up to "Foreign Listeners' Four"? If it can be arranged, I should like to retain the feature of "free" grid bias, although if this is inconvenient, I should not object to a bias battery when the set is being used for gramophone reproduction.

E. N. B.

There is little difficulty in retaining the free grid bias feature when operating this set with a pick-up. We suggest that the detector grid circuit should be connected in the manner shown in Fig. 2, from which you will see that a small resistance is inserted in the detector cathode lead, as in the case of the remaining valves of the set. When the switch is in the "detector" position, the grid is not affected by the potential difference existing across the biasing resistance, as the grid condenser acts as an effective insulator, and the operating conditions of the valve are exactly as before.

For the sake of completeness, we show the grid circuit of the second H.F. amplifier, in order that you may compare the method adopted in providing for the biasing of this valve.

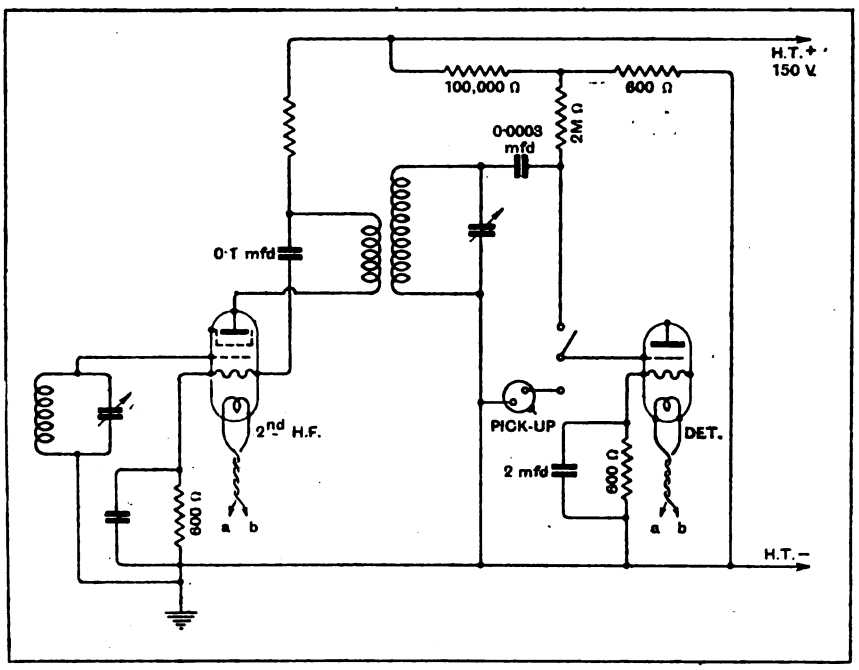

Fig. 2.—Method of inserting a pick-up in the detector grid circuit of the "Foreign Listeners' Four." Reference lettering corresponds with that of the original circuit diagram.

o o o o

On the H.F. Side.

Will you please examine the enclosed circuit diagram of my receiver and tell me what is wrong with its L.F. amplifier? When the H.T. battery is connected, violent motor-boating is produced when the circuits are brought into tune.

R. D. G.

The circuit diagram submitted by our correspondent represents a three-valve receiver with transformer-coupled H.F. amplifier and anode bend detector, resistance-coupled to a pentode. A choke-filter device is included. Now, a circuit of this kind is inherently immune from low-frequency interaction troubles, even without the decoupling devices included in the detector anode circuit, and we feel certain that the trouble really lies in the H.F. end of the receiver. It would appear that high-frequency oscillation is produced as the circuits are brought into tune; this may be due either to insufficient screening, or merely to the fact that attempts are being made to attain a greater stage magnification than the valve is capable of yielding.

We think it would be advisable to test the leak resistance associated with the grid circuit of the output valve; it seems probable that choking in this circuit gives rise to an effect similar to that usually described as "motor-boating."

o o o o

External Interference or Internal Fault?

I am troubled by an intermittent crackling noise from my loud speaker which sometimes lasts for as long as ten minutes, and then suddenly ceases. Can you tell me whether this is due to the receiver, to the eliminator, or to interference from power circuits?

H. B. B.

From the information given we feel that it is quite impossible to offer a definite opinion, although we are inclined to think that the trouble is due to interference from outside sources.

It would probably be easy enough for you to prove whether the eliminator is at fault by temporarily substituting a set of batteries, and with this form of supply you could ascertain fairly conclusively whether there is a fault in the set by noting whether the interference persists when aerial and earth are removed.

It may be added that in cases of this sort we are always inclined to suspect grid biasing batteries, inductive windings, such as chokes, and more particularly L.F. transformer primaries.

o o o o

An Inevitable Earth.

I am told that when using D.C. mains for H.T. supply it is possible to earth the receiver through the mains. Will you tell me how this may be done?

C. S.

It is inevitable that any set deriving its H.T. supply from D.C. mains should be earthed, as without exception public supply mains are connected to earth at the generating station. There is no need for any extra connection, and, although the normal earth terminal of the receiver is left free there will still be an "earth."

It should be pointed out, however, that this form of earthing is not highly effective, and as a general rule another connection is advised.

o o o o

Free Grid Bias Scheme.

I am thinking of building the "Flat Dwellers' A.C. Three," but should like to include the scheme of "free" grid bias included in the "Foreign Listeners' Four." Is there any reason why this should not be successful?

D. R. L.

As far as the H.F. and output valves are concerned, it would be quite easy to arrange for free grid bias by inserting resistances in the cathode leads, but it would be almost impossible to apply this simple method to the detector, which, as you will realise, is arranged to work on the anode bend principle.

If you are particularly anxious to proceed with your scheme, we suggest that bias for the detector could best be taken from a resistance inserted in some part of the circuit where current flow is fairly heavy, and not from one of the circuits associated only with this valve itself.

o o o o

Where the Frame Aerial Fails.

Can it always be assumed that a frame aerial set will be more selective than one with an open aerial? I am considering the design of a new receiver, and, in view of the proximity of Brookman's Park, am wondering which form of collector will be the more suitable.

J. W. J.

A good deal depends on the purpose for which the set is intended. If it is desired to receive only the two projected alternative transmissions from Brookman's Park, then it may be stated definitely that the frame will contribute nothing towards real over-all selectivity; both stations are on the same site, and its directional properties will serve no useful purpose. If, on the other hand, the reception of other and more distant stations is needed, it will be of the greatest advantage.

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EMPIRE BROADCASTING.

A NEW and energetic Government,—a new Chief Engineer of the B.B.C. who has, as yet, not curtailed his future activities by compromising utterances on questions of B.B.C. technical policy,—and it would seem that here we have two factors which offer a brighter outlook for the prospects of a new policy in regard to Empire broadcasting.

There has been ample evidence in the past that the B.B.C. will do nothing in the direction of furthering the cause of Empire broadcasting until they are pressed into doing it, and until they are told what course they should pursue. The suggestion that an Empire broadcasting service should be started originated in a contribution in *The Wireless World*, and later, in our issue of April 27th, 1927, we said: "It is a matter for regret that we should so far have neglected to take advantage of the wonderful opportunity which broadcasting provides for communication with the outlying sections of the Empire." By May of the same year the daily Press had taken up the question, and in an article which appeared in the *Evening Standard*, of May 5th, 1927, the comment appeared: "If a foreign station can successfully transmit to the Antipodes on a wavelength of 30 metres there seems to be no logical reason why our own Corporation should not begin to delve a little deeper into the possibilities."

By the end of that month we were able to announce: "The efforts of *The Wireless World* to stir up interest in the subject of Empire broadcasting already show definite promise of bearing fruit in the near future. The daily Press has taken up the subject with interest, and the B.B.C. has issued a statement giving its view of the position." By June 1st, 1927, we were able to state that, "Since the publication of our last issue matters in connection with Empire broadcasting have proceeded apace. The B.B.C. has made an announcement to the effect that they are undertaking the erection of a short-wave station at Daventry."

How 5SW Started.

In our issue of June 29th, 1927, we criticised the delay in proceeding with an Empire short-wave station and suggested a remedy. The B.B.C. had stated that they were erecting a short-wave station for experimental work at Daventry, but we drew attention to the fact that "The preliminary work of an experimental kind before the first B.B.C. stations were established was undertaken by the big wireless companies, and when a long-wave station (Daventry 5XX) was decided upon it was first established, and all experiments conducted in connection with it, at the Marconi Company's Works at Chelmsford," and we continued: "We sympathise with the attitude of the B.B.C. that it is not justified in incurring heavy expenditure on experimental work; but such experimental work, we believe, would readily be incurred by one of the big commercial companies if the station, when established in going order, and after having passed specified tests, could be handed over to the British Broadcasting Company at an agreed price."

As we know, our advice that the technical development of the Empire short-wave station should be initiated by the Marconi Company on behalf of the B.B.C. was adopted, and we still have, to-day, 5SW located at the Marconi Works at Chelmsford. But there matters have stood still, and we would now urge Capt. Eckersley's successor and his staff to show the same degree of enthusiasm for achieving results with a short-wave Empire broadcasting service as, on other wavebands, has already resulted in a success which has earned for British Broadcasting a reputation second to none.

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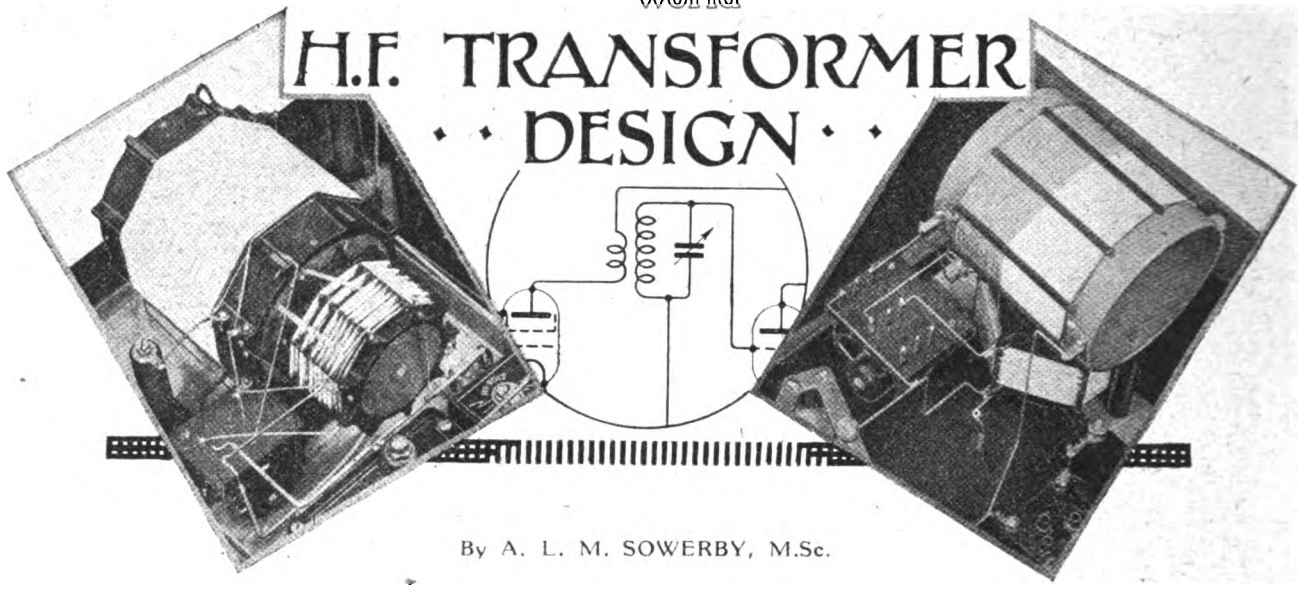
H.F. TRANSFORMER DESIGN



By A. L. M. SOWERBY, M.Sc.

Adjusting Ratio to Compromise between Amplification and Selectivity.

WHEN using a triode as a high-frequency amplifier in conjunction with any reasonable tuned circuit it is quite essential, as has many times been pointed out in the pages of this journal, to use a high-frequency transformer with a secondary winding containing several times as many turns as the primary. Even apart from the question of stability it will be found that a tuned anode circuit or its equivalent provides both lower amplification and worse selectivity than a properly designed transformer.

When using a screen-grid valve with a tuned circuit of normal losses the best number of turns for the primary of the transformer is very nearly the same as the number of turns on the secondary. For example, using a screen-grid valve of A.C. resistance ("impedance") $R_a = 200{,}000$ ohms before a tuned circuit of dynamic resistance $R = 250{,}000$ ohms, the optimum ratio, as given by the formula $n = \sqrt{\frac{R}{R_0}}$ comes out at 1.11. Thus if the secondary contains 70 turns there should be $\frac{70}{1.11}$ or 63 turns on the primary.

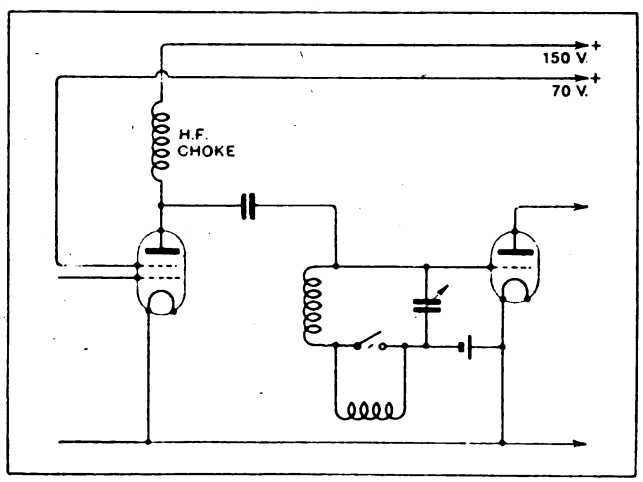


Fig. 1.—The tuned grid circuit, showing simplicity of waveband switching. Range-changing can also be achieved by changing one coil.

Now, in many cases the use of the tuned anode circuit, or its close equivalent, the tuned grid circuit (Fig. 1), would be preferred to a transformer for the sake of greater ease in wave-band switching or coil-changing. Using a transformer, there are two coils, primary and secondary, that have to be changed in passing from one wave-band to another, so that a four-connection mount is needed if the transformer is to be changed, while if switching is adopted a two-pole switch is required, as in Fig. 2, to short out the long-wave primary and secondary when receiving on the broadcast band. With either the tuned anode or the tuned grid circuits, on the other hand, the same end is achieved by a two-connection coil or, as in Fig. 1, by a single-pole switch.

Tuned Anode *versus* Transformer.

If, in the interests of simplicity, either of these more convenient circuits is adopted, it becomes pertinent to enquire how much of the possible amplification will be sacrificed by employing what is, in effect, a 1:1 transformer (since the same coil now does duty both as primary and secondary) in place of a transformer of the correct step-up ratio.

The appendix contains a calculation that leads to a formula, applicable to all cases, for comparing the amplification yielded by the tuned anode circuit with that given by a theoretically perfect transformer. For greater convenience in reference there is plotted in Fig. 3 a curve from which the desired numerical result can be read off at a glance for any case for which the best transformer ratio is known. In the case taken as an example, and for which the best transformer ratio was found to be 1:1, the curve shows that the

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H.F. Transformer Design.—

amplification attained if a tuned circuit were substituted would be 99 per cent. of that to be expected from the transformer. Even the most enthusiastic efficiency hunter would hardly be appalled at the prospect of sacrificing one per cent. of his amplification for the sake of the extra convenience of the simpler circuit! If, however, the correct transformer ratio had been 2, implying a primary with half as many turns as the secondary, the amplification with the tuned anode circuit would be 80 per cent. of the highest attainable with the valve and tuned circuit to be used, while selectivity would also suffer by the change.

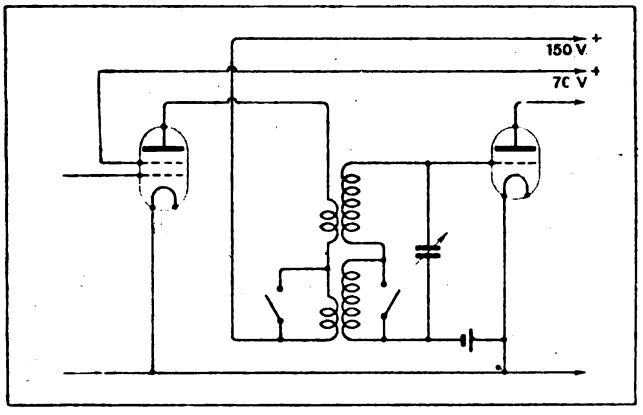

Fig. 2.—Waveband switching with a transformer. The separate switches shown would in practice be combined into a single two-pole switch.

There are, however, some other factors to be taken into consideration. With a transformer having a ratio in the neighbourhood of 1:1 the amplification, though theoretically the same as that yielded by tuned anode, is in practice found to be lower by some five or six per cent., owing to the slightly incomplete coupling between the two windings, and to the losses introduced by the wire of the primary. As a result of this, the theoretical losses due to replacing by tuned anode of a transformer of ratio anywhere between 1 to 1 and about 1.4 to 1 do not appear in practice, so that a tuned circuit having a dynamic resistance anywhere between double and half the value of the A.C. resistance of the valve will yield, with tuned anode coupling, the highest amplification that can be extracted from that particular combination of coil and valve.

Tuned Grid Coupling.

If the receiver is to be used with an eliminator it will usually be preferred, for several excellent reasons connected with decoupling, to use the tuned grid circuit of Fig. 2 in place of tuned anode. Although this may theoretically be considered as an equivalent of tuned anode, it is in practice a little inferior owing to the high-frequency losses introduced by the choke. As a first approximation, we may set this off against the small losses that are equally inevitable in the transformer, so that if it is desired to compare the probable performance of the tuned grid circuit with that of a transformer with a primary designed to suit the valve and coil to be used the curve may be taken as it stands, without the small correction suggested for tuned anode. Unless some care is expended in the selection of a choke a correction in the other direction may be necessary, for the loss in amplification in such circumstances will be a good deal greater than the curve would suggest.

In the formula from which the curve was computed no restrictions were made confining the conclusions to step-up transformers. In terms of receiver design this implies that the curve covers cases such as arise with some of the very high-impedance screen-grid valves now produced, where theory indicates that a step-*down* transformer should be employed. Suppose we propose to follow a Cosmos AC/S valve, of nominal A.C. resistance 800,000 ohms, with a tuned circuit of dynamic resistance 250,000 ohms. Here $\sqrt{\frac{R}{R_0}} = \frac{250{,}000}{800{,}000} = 0.56$. The secondary must have 0.56 times the primary turns, which is a step-down ratio of $\frac{1}{0.56}$ or 1.79 to 1. Referring to the curve, we find that the tuned anode (or a 1 to 1 transformer) will give 85 per cent. of the amplification that would be attained if the practical difficulties of using a transformer with so large a primary had been satisfactorily overcome. While one may hanker after the lost magnification, one may at least feel consoled that the loss is not, perhaps, so great as one had thought, especially as some of the loss will be made up automatically when, in choosing the best screen-grid voltage, the A.C. resistance of the valve is adjusted to the best compromise with the coil used.

Poor Selectivity with Screen-grid Valve.

Those who read the appendix will notice that the expression obtained is symmetrical in *m* and *n*. This fact further extends the applicability of the curve to cover the inverse problem, which also has considerable practical interest, of finding the loss in amplification incurred through using a step-up transformer when a tuned-anode circuit is theoretically correct. We have all discovered, through practical experience, that the

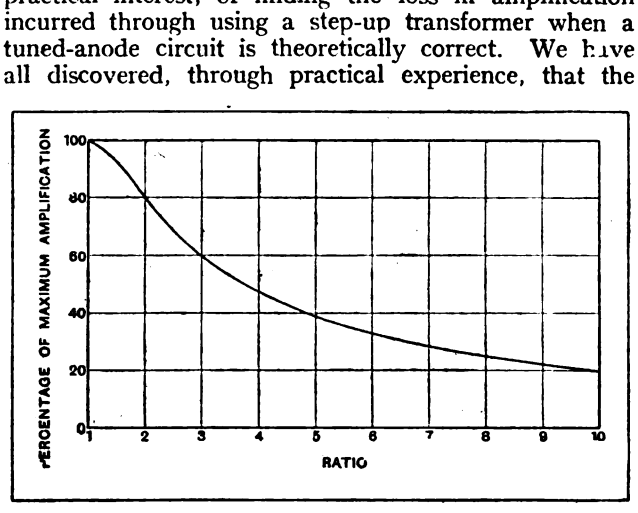

Fig. 3.—(a) When a transformer of ratio *m* is correct, and tuned anode is to be used, the percentage amplification yielded is read from the curve against *m* on the "Ratio" scale. (b) When tuned anode is theoretically correct, the curve gives the percentage amplification for a transformer of any ratio. (c) When a transformer of ratio *m* is correct, and one of ratio *n* is to be used, the percentage amplification yielded is read from the curve against *n*/*m* (or *m*/*n*) on the "Ratio" scale. (See Appendix.)

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H.F. Transformer Design.—

screen-grid valve, used with a tuned-anode circuit or its approximate equivalent, makes for a receiver of very poor selectivity, though the theoretical basis for this would appear at present to be obscure. This poor selectivity is usually combated by using a step-up transformer with a primary a good deal smaller than theory, directed towards maximum stage again, would demand. The gain in selectivity is undoubted—but how about the loss of amplification?

Combating Loss in Amplification.

Provided always that the optimum ratio, as calculated from the formula, is 1 to 1, the curve will give straight away the loss of amplification incurred by using a step-up transformer of any ratio that the needs of selectivity may prescribe. To take an example, a 200,000 ohm tuned circuit after a 200,000 ohm valve needs a 1-to-1 transformer if we are legislating for amplification only, and with this transformer the amplification of the stage will be exactly half the "μ" of the valve. If we decide that a 3-to-1 transformer is necessary to provide the selectivity we require, the stage gain will be reduced, as the curve shows, to 60 per cent. of the possible value, or with a 4-to-1 transformer to 47 per cent., making the actual figure for amplification 60/200ths or 47/200ths respectively of the amplification factor of the valve.

Even when the theoretically correct ratio is not 1 to 1, this remarkably versatile curve does not admit its inability to deal with the problem reasonably simply. Instead of looking up directly on the horizontal scale the transformer ratio that we propose to use, we divide the proposed ratio by the theoretical ratio, and look up the result as before. Two cases are needed to illustrate this point fully.

First let us take the case of a valve of $\mu = 200$, $R_0 = 200{,}000$ ohms, used with a tuned secondary of dynamic resistance 300,000 ohms, and a primary which, for the sake of selectivity, shall only contain one-fourth as many turns as the secondary. How much amplification do we sacrifice to selectivity, and what will be the actual amplification of the stage when set up?

The theoretically correct ratio for the transformer is not 4, but $\sqrt{\frac{R}{R_0}} = \sqrt{\frac{300{,}000}{200{,}000}} = 1.23$. With this an amplification of $\frac{1}{2}\mu n = \frac{1}{2} \times 200 \times 1.23 = 123$ times would be expected. To find what percentage of this we shall attain with the 4-to-1 transformer, we divide proposed ratio by theoretical ratio, getting $\frac{4}{1.23} = 3.25$. Looking up 3.25 on the curve, we find that this figure corresponds to 56 per cent. of maximum amplification, showing that, even with the 4-to-1 transformer, more than half the maximum attainable amplification is still to be had. The stage as planned will amplify 56 per cent. of 123, or 69 times.

For our second example we will take the AC/S valve again, and assume that we propose to use with it a 2-to-1 step-up transformer having a secondary of 200,000 ohms dynamic resistance. Here the valve characteristics are $\mu = 1{,}200$ A.C. resistance $= 800{,}000$ ohms. Optimum ratio $n = \sqrt{\frac{R}{R_0}} = \sqrt{\frac{200{,}000}{800{,}000}} = 0.5$ (primary twice as many turns as secondary). This would give an amplification of $\frac{1}{2}\mu n = \frac{1200}{4} = 300$ times. But we propose, for the sake of selectivity, to use a 2-to-1 step-*up* transformer, with half as many turns on the primary as on the secondary. Dividing proposed by theoretical ratio we get $\frac{2}{\frac{1}{2}}$ or 4, which corresponds on the curve to 47 per cent. of maximum amplification. We shall therefore achieve a magnification of 47 per cent. of 300, or 141 times, in our receiver.

Incidental Reaction.

In any case where a step-up transformer of comparatively high ratio is chosen, for the sake of enhancing selectivity, to follow a screen-grid valve, the incidental reaction due to the incomplete screening within the valve will also be reduced, as is evident from the fact that set designers often use step-up transformers for the purpose of ensuring stability. This effect, though perfectly amenable to calculation if the necessary data are to hand,[1] cannot be expressed in a simple curve, and is therefore not treated quantitatively in the present note. It is thought, however, that the curve given will be found useful in obtaining a rapid solution to some of the problems incidental to the design on modern lines of a stage of high-frequency amplification.

Appendix.

For two transformers, of ratio n and m, but otherwise identical, we have

$$A_1 = \frac{n\mu R}{R + n^2 R_0}$$

and

$$A_2 = \frac{m\mu R}{R + m^2 R_0}$$

$$\therefore \frac{A_1}{A_2} = \frac{n}{m} \cdot \frac{R + m^2 R_0}{R + n^2 R_0} = \frac{n}{m} \cdot \frac{R/R_0 + m^2}{R/R_0 + n^2}$$

if the ratio m is the optimum, $R/R_0 = m^2$

For any value of n,

$$\frac{A_1}{A_2} = \frac{n}{m} \cdot \frac{2m^2}{m^2 + n^2} = \frac{2mn}{m^2 + n^2} = \frac{2m/n}{(m/n)^2 + 1}$$

$$\therefore \frac{A_1}{A_2} = \frac{2}{m/n + n/m}$$

In the curve of Figure 3, $\frac{100A_1}{A_2}$ is plotted against m/n (or n/m) from the above expression.

[The formula for amplification upon which this calculation is based will be found in "Radio-frequency Transformers," by N. W. McLachlan, *Experimental Wireless*, October, 1927, p. 597.]

[1] See R. T. Beatty, *Experimental Wireless*, Jan, 1928, p. 3.

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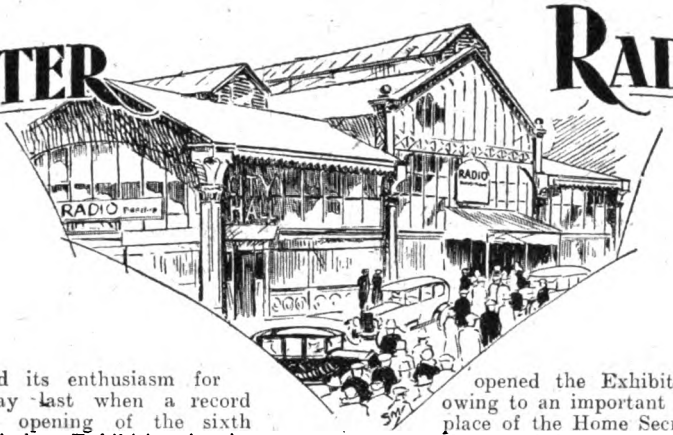
MANCHESTER RADIO SHOW



New Items of Interest — Seen at the Stands.

MANCHESTER reaffirmed its enthusiasm for wireless on Wednesday last when a record crowd attended the opening of the sixth annual *Evening Chronicle* Wireless Exhibition in the City Hall.

In a speech which must have reassured many anxious listeners, Mr. Gladstone Murray, of the B.B.C., declared that the opening of the Moorside Edge Regional Station in a year's time would provide the North with a much better broadcasting service than at present. Referring to criticism of the use of the microphone by cabinet ministers, Mr. Gladstone Murray said that neither the present nor the previous Government had misused the microphone, nor was the slightest pressure brought to bear upon the B.B.C. in the conduct of its services.

Mr. J. R. Clynes, the Home Secretary, who was to have opened the Exhibition, was unable to be present owing to an important Cabinet Meeting. In taking the place of the Home Secretary, the Lord Mayor of Manchester (Colonel Westcott) delivered a rousing speech, in which he congratulated the organisers on the large attendance at the opening of the Exhibition, and referred to the now recognised fact that Manchester is in the forefront of radio development.

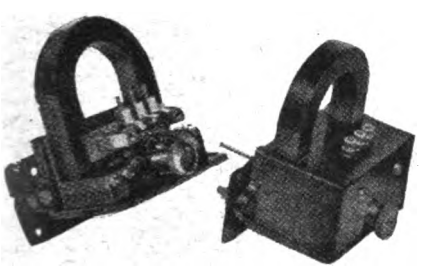
Other speakers included Captain P. P. Eckersley and Mr. Edward Liveing, Regional Director for the Northern Group of B.B.C. stations.

The following review of the Show forms a comprehensive survey of the "Olympia of the North." The Exhibition will remain open daily until Saturday next, October 26th. Admission is 1s. 2d., including tax.

Apparatus exhibited at many of the stands has already been described in detail in the recent report of the Olympia Show. To avoid repetition, attention has been devoted in particular to sets and components now shown for the first time.

AMPLION. (32)

In addition to the new apparatus described in our Olympia Show Report, an Amplion balanced armature loud speaker drive unit—Type B.A.2—has just been



New Amplion balanced armature loud speaker unit, with and without cover.

introduced. This component will be examined with more than usual interest, as it embodies features not to be found (the writer believes) in any other unit, yet available. In the first place, there are three input terminals, so arranged that the user has a choice of three distinct resistance values of 500, 700 and 1,200 ohms, corresponding to impedances at 1,000 cycles of, respectively, 4,500, 6,500, and 20,000 ohms. The high-resistance winding is stated to be specially designed for use in conjunction with a pentode output valve.

The vibrating reed is held in position between two restraining springs, one of which is adjustable, while the other is normally fixed. When sent out from the works, this is set so that the sensitivity of the unit is fairly high, but its capabilities in the matter of power handling is not in excess of normal requirements; where exceptionally great outputs from the receiver are available, this second spring may be easily adjusted, so that the unit will be capable of delivering greater volume without "chattering"; at the same time, sensitivity will be reduced.

A removable back plate is supplied with the unit, in order that it may be mounted on a cone chassis drilled in accordance with several standard arrangements.

Graham-Amplion, Ltd., Slough, Bucks. Sales Offices, 25-26, Savile Row, London, W.1.

Aeonic portable receiver.

ATLAS. (41)

The new Clarke Atlas H.T. eliminator, Type A.C.16, seems to be admirably suited for supplying anode current for any of the more popular circuit arrangements of the present day. It is for use

Atlas H.T. eliminator with outputs arranged to suit the most popular modern circuits.

with an alternating current supply, includes a valve rectifier, and is mounted in the neat type of olive green finished metal container which is always associated with the products of this firm.

Three voltage outputs are provided; the first, variable up to 100 volts, is regulated by means of a potentiometer, so it is quite suitable for supplying the screening grid of an H.F. amplifying valve. A fixed output of 120 volts is obtained through a series resistance, which can be

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pressed into service for preventing anode circuit interaction when suitably connected to the receiver. Lastly, there is a main output tapping rated at 150 volts, 25 mA.

This eliminator costs £4 10s.; a similar model for D.C. mains, with the same arrangement of output terminals, is sold at £3 10s.

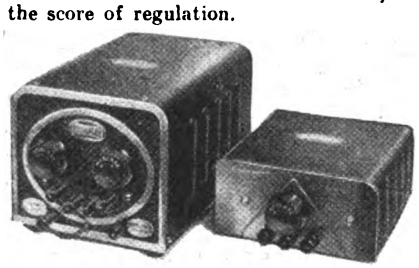
Atlas plug-in coils and Pirtoid coil formers are again exhibited, together with a new compression-type variable resistance, having a continuous adjustment between about 200 ohms and 1 megohm. This latter component is stated to be capable of dissipating 10 watts.

H. Clarke and Co. (Manchester), Ltd., Atlas Works, Old Trafford, Manchester.

BEARDSALL. (2)

This company act as agents for Regentone products, well known for "radio-from-the-mains" components and accessories.

A large number of A.C. and D.C. eliminators are being shown, also combined chargers. For those who have replaced their ordinary filamented valves by the type with indirectly heated cathodes and who already have an H.T. eliminator, there is a filament transformer available at 12s. 6d., giving an output of 4 amps. at 4 volts. Separate filament and anode mains transformers have a certain amount to be said in favour of them, on the score of regulation.



Two Regentone eliminators. (Left) W2A type. (Right) W1C type. Exhibited by Beardsall.

The Regentstat is a British-made non-wire-wound continuously variable resistance with a dissipation not to exceed 10 watts. It does not contain graphite and mica, and it is claimed that it does not "pack"; the price is 7s. 9d.

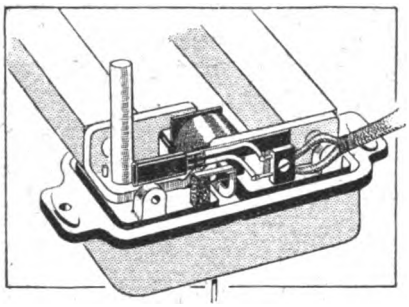
The W.I.C. eliminator for A.C. mains at £3 15s. represents good value for money. A Westinghouse copper-oxide rectifier and liberal filtering equipment are included. The total output at 120 volts is 18 mA., which is delivered from two tappings, the first of which is variable, allowing for the feed to a screen-grid valve. The W.2A eliminator is an elaborate unit, selling at £7 15s., and capable of giving 50 mA. at 160 volts. There are three tappings, two of which are variable; the unit is thus suitable for feeding a set having an S.G. valve and an anode bend detector.

A range of power chokes and mains transformers is being shown.

W. E. Beardsall and Co., Ltd., 3-5, Victoria Bridge, Manchester.

BLUE SPOT. (30)

The Blue Spot loud speaker unit is too well known to require description here.



Interior of the new Blue Spot movement.

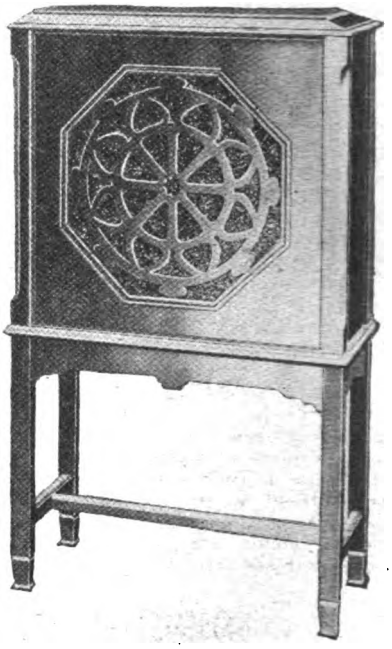
It is to be noted at the stand that a new model has made its appearance, known as the Type 66K. While externally resembling previous models, it has been modified to handle more input. The differential armature assembly provides for generous displacement and the winding has a resistance of 1,500 ohms. The impedance is given as 10,000 ohms at 1,000 cycles, and the winding has a mean D.C. current-carrying capacity of 25 mA. One appreciates the concise information given in the four-page pamphlet which accompanies the unit. This describes in a very practical way the building of two forms of cone loud speaker.

H. C. Rawson (Sheffield and London), Ltd., 100, London Road, Sheffield. (F. A. Hughes and Co., Ltd., 204-206, Great Portland Street, London, W.1.)

BROWNIE. (38)

A three-valve receiver that is proving popular is the Dominion Console which, complete with self-contained loud speaker but without valves or batteries, is priced at £9. The three-valve receiver amplifier is built as a single moulded unit carrying three terminals for aerial and earth connections, terminals for gramophone pick-up, as well as a pair of terminals for connecting an external loud speaker. As the components are completely protected the back of the instrument is left open, which probably gives an advantage as regards the performance of the loud speaker, this being a 12in. cone driven by an adjustable 4-pole balanced armature.

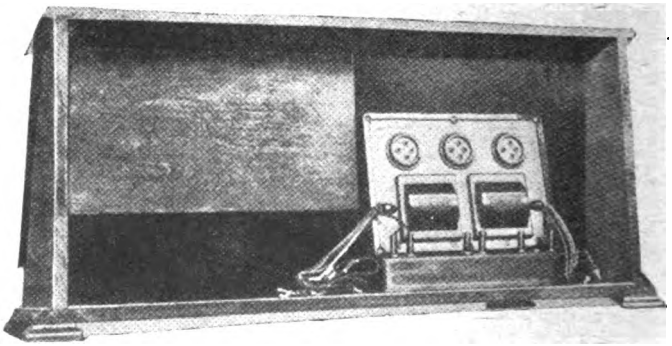
Brownie Wireless Company of Great Britain, Ltd., Nelson Street Works, Mornington Crescent, London, N.W.1.



The Celestrola loud speaker. A moving-coil model, manufactured by Celestion.

CELESTION. (42)

The loud speakers made by this firm need little introduction to readers. The well-known "C" type have been reduced in price; the "C12," for instance, is now £5 12s. 6d. A new series has been introduced this season, known as the "Z" class; the reinforced diaphragm is retained, but there is a new electro-magnetic movement which it is claimed gives an even wider frequency response than that in former models. The "Celestrola" (erroneously called the "Celestroda" in our Olympia report) is a moving-coil instrument capable of



Interior view of the Brownie Dominion Console receiver showing the unit construction of the amplifier.

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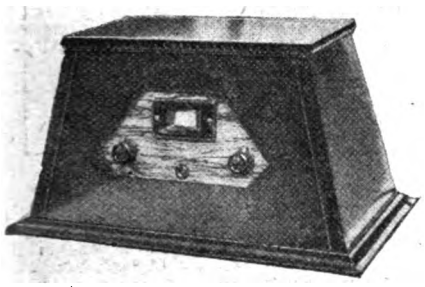
giving a very large acoustic output. There are a number of models with suitable field design for D.C., A.C., or battery operation, and in each case the speech coil is centred by three flexible metal strips.

Celestion, Ltd., London Road, Kingston-on-Thames.

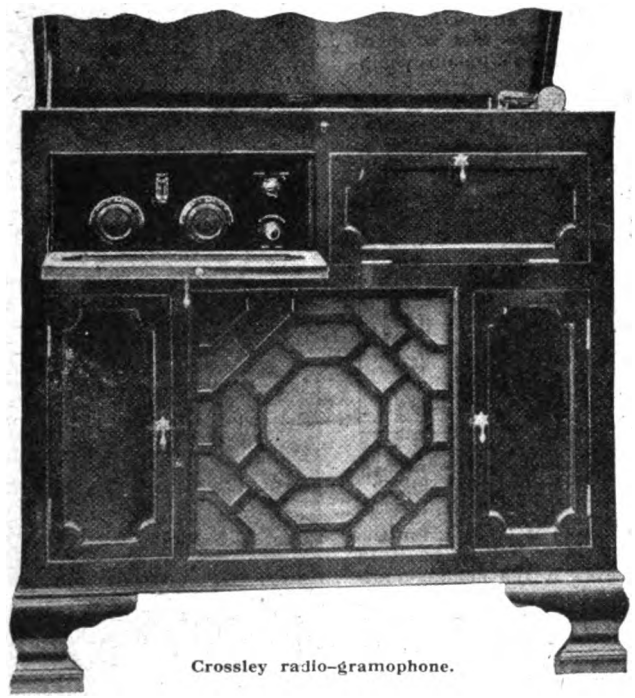


The new Climax Chelloset. A two-valve all A.C. mains-operated receiver.

CROSSLEY. (89)

The Crolectro 4-valve radio-gramophone, besides being a beautifully finished piece of furniture, will delight the heart of the student who follows the latest trend in radio technique. The gramophone equipment includes a B.T.H. electric motor and pick-up, the latter being switched into the detector grid circuit. The whole set derives H.T., L.T., and bias from A.C. mains, and, except for the output stage where raw A.C. is used (a common practice to-day), valves with indirectly heated cathodes are employed. The outside aerial is coupled by a double circuit to a Mazda AC/SG valve, which in turn is coupled to the anode bend detector (a Mullard 164 V.) by a Litz 3in. transformer with a small step-up ratio. No reaction is employed, and the screening in three planes is very complete. The volume control for both radio and gramophone is a variable resistance across the primary of the input push-pull transformer which directly follows the detector. Two Mazda P.650 valves are coupled to a Rice-Kellogg moving-coil speaker by means of an output push-pull transformer. A separate Westinghouse metal oxide rectifier provides grid bias and avoids the necessity of elaborate anti-motor-boating devices. The instrument is built on sound lines and contains those fine points in design which make for high sensitivity and good quality of reproduction.

Geo. Crossley and Son, Ltd., 4, South Street, Manchester.



Crossley radio-gramophone.

DUBILIER. (33)

Practically every component necessary for the construction of a wireless receiver is manufactured by this company. In addition to the well-known comprehensive range of condensers with both mica and paper dielectric, also anode resistances, R.C.C. units, chokes and grid-leaks, there is being marketed this season a series of dry-cell H.T. batteries known as the "Superior" and "Supreme" types. The recommended load for the former is 6, and the latter 16mA. The life curve submitted by the makers shows a drop to only 0.8 volts per cell after 1,000 hours. The 108-volt battery of the "Superior" series, for instance, costs 12s. 9d., whilst the 60-volt "Supreme" model is 13s. 6d.

The new all-mains 3-valve receiver can be obtained for D.C. or A.C. supplies at £25. The aerial and interstage inductances are toroidal transformers, and although the detector works on the anode bend principle, reaction is used and applied to the interstage coupling. The valves in order are AC/SG, AC/HL, and AC/P, and the rectifier is a U.30/250. A purchaser of the D.C. model can have it converted to A.C., when his mains supply is changed, for the sum of £6.

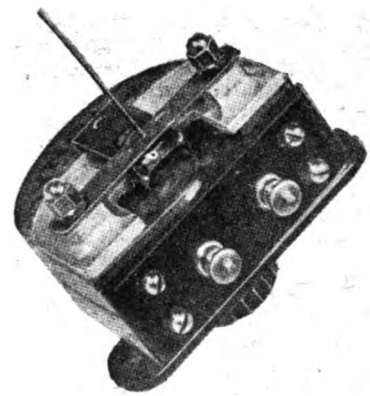
Dubilier 3-valve receiver for A.C. mains.

Dubilier Condenser Co. (1925), *Ltd., Ducon Works, Victoria Road, North Acton, W.3.*

DYNOMAG UNITS. (121)

Among the components shown is a new cone unit working on the balanced-armature principle, and a large range of Mansbridge condensers of high-voltage test for eliminators.

A series of well-designed permanent magnets made by Swift Levick are exhibited. There are also a number of grid leaks and anode resistances, having wire end-connectors, thus enabling these components to be suspended in the wiring without the use of holders and clips.



Cone unit shown by Dynomag Units, Ltd.

A. M. E. Sherwood, 68, Hatton Garden, E.C.1.

EDISWAN. (27 and 28)

(Incorporating B.T.H. and Metro-Vick.)

In view of the fact that this stand contains the radio products of three well-known firms, there are such a large number of sets and components that space

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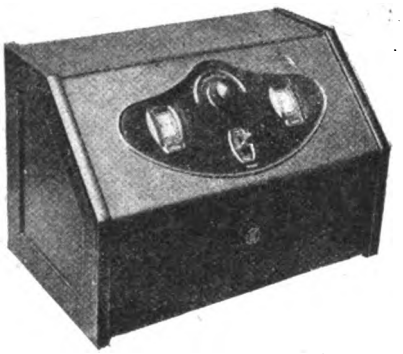
forbids the description of more than a few. The reader is referred to the Olympia Stand-to-Stand report. The new Mazda valves, which have remarkable characteristics, are being exhibited. Perhaps the most striking member of this series is the AC/SG valve, in which the inter-electrode capacity has been lowered to what would appear to be the irreducible limit of 0.0045 mmfd. Such minute feed-back occurs through the valve that the coils on either side of it (i.e., grid and anode) can be made of so small a high-frequency resistance that the valve does not oscillate until a stage amplification of about 250 times is attained. This figure, when compared with a maximum of about 80 with screened valves of last year, is very striking.

The 215 S.G. is a battery-fed screened valve with which it is possible to obtain a stage amplification of about 150 with stability if the external screening is carried out with great care.

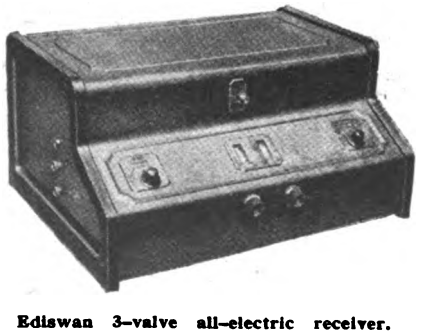


Ediswan 3-valve battery receiver.

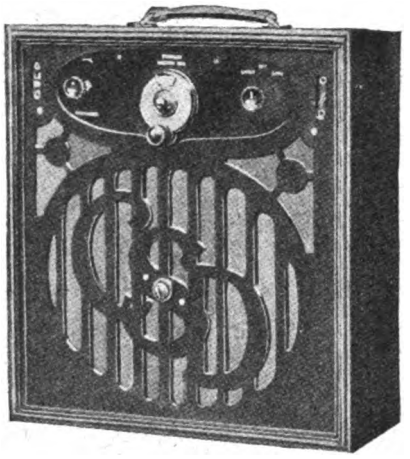
The two-volt battery valves, one of which has a mutual conductance approaching 4 mA. per volt, should prove popular both for the portable set and for the man who has to carry his L.T. accumulator any distance to the charging station. There are new Mazda pentodes and a range of indirectly heated cathode valves for every position in a receiver.

The all-mains receivers merit the careful attention of prospective set buyers, as their design is the result of the combined resources and experience of the Ediswan Company, the B.T.H. Company, and Metro-Vick Supplies. A three-valve battery-operated receiver, selling at the popular price of £9 12s. 6d., has interesting points in design and incorporates the Mazda 215 S.G. valve.

Edison Swan Electric Co., Ltd., 123-125, *Queen Victoria Street, E.C.*4.



Ediswan 3-valve all-electric receiver.

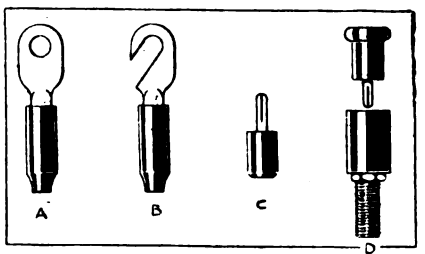


Dunham transportable receiver.

EELEX. (101)

Besides distributing the products of well-known radio manufacturers, this company exploits a number of components of their own. A shock-proof eliminator terminal in which contact is made within a countersunk insulator should find considerable application now that so much attention is being paid to all-mains equipment.

There is a treble-duty terminal to take every variety of spade and pin connector; also a series of split-eyelet connectors so fashioned as to make it difficult for the terminal and the wire leading to it to part company, even if the holding-down screw has become loose.



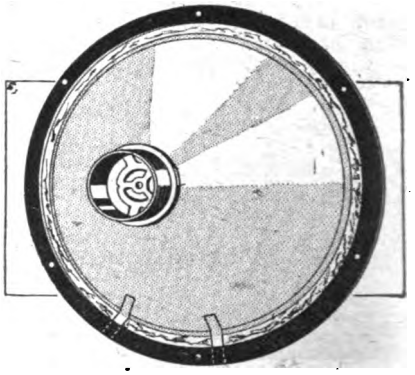
Eelex connectors. (A) Eyelet type. (B) Slotted eyelet. (C) Midget wander-plug. (D) Shock-proof eliminator terminal.

For portable sets, where space is limited, a midget wander plug being shown should prove useful.

J. J. Eastick and Sons, Eelex House, 118, *Bunhill Row, E.C.*1.

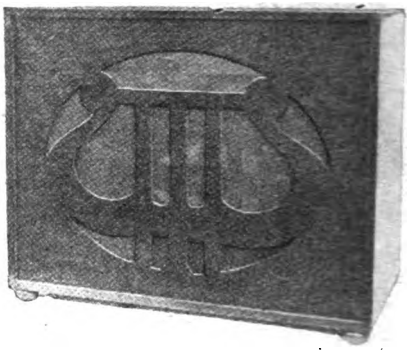
EPOCH. (103)

Since the Olympia Show an addition has been made to the range of Epoch loud speakers by the production of the Model 99. The usual form of edge suspension is here dispensed with, and instead locating pieces are provided. The freedom thus obtained largely removes resonances within the cone itself. The surround is, however, effectively sealed to prevent air leakage between the two faces of the diaphragm.



The new Epoch free-edge cone as fitted in the Model 99 loud speaker.

Moving-coil loud speakers of the permanent magnet type and remarkable for their high flux density are attracting the attention of those who seek quality but have no mains supply.



A popular priced loud speaker cabinet with grille at back and front (Epoch).

The well-arranged interior of the Metropolis portable. It is a five-valve superheterodyne produced by the Empire Electric Company.

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Loud speaker cabinets in various grades with or without loud speaker are available in a wide range of prices covering all requirements.

Epoch Radio Manufacturing Co., Ltd., 3, Farringdon Avenue, London, E.C.4.

FERRANTI. (52, 53 and 115)

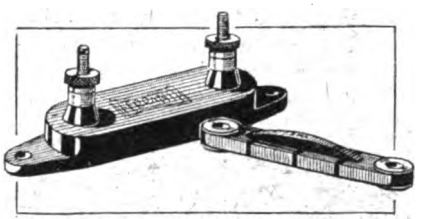
In view of the recent detailed description given in respect of the range of Ferranti products shown at Olympia, mention need only be made here of new items of interest.

Interior view of the new Ferranti mains-operated receiver.

The Ferranti A.C. mains receiver Model 31, while now being shown in a new and attractively finished form of cabinet, may be carefully inspected as to its interior make-up. Liberties have not been taken in the direction of cheapening the construction of this complete receiver, and the specialised Ferranti components are of standard form. In the tuned circuits associated with the indirectly heated screen-grid valve we find coils carried on slotted ribbed formers. An interesting detail is the adoption of a Bowden wire coupling to rotate the reaction coil. As a long-range receiver leaky grid detection is provided, maximum amplification being produced by the use of the newly introduced AF6, an intervalve transformer with a 1 to 7 ratio, and which is actually larger than the well-known AF5. The output valve is a P.625, and is associated with a double ratio transformer permitting of the use of loud speakers having either high or low resistance windings. Grid biasing is obtained by an independent Westinghouse rectifier, the H.T. supply being provided by a valve rectifier, the U.5. Volume control is by adjustment of grid bias of the H.F. valve. A safety switch disconnects the current when the instrument is opened. The consumption from the mains is about 50 watts, and the undistorted signal output rating is 700 milliwatts.

Small mica condensers and high resistances of the grid-leak type now make their first appearance. The leaks, which are made of high resistance material, have a current-carrying capacity up to about 5 mA., and are available in the resistance values of 20,000 ohms to 5 megohms. These resistances, which are not easily broken, are accurately adjusted by reducing the cross section. Their price is 1s. 6d.

Apart from the new 1 to 7 intervalve transformer, which is specially intended



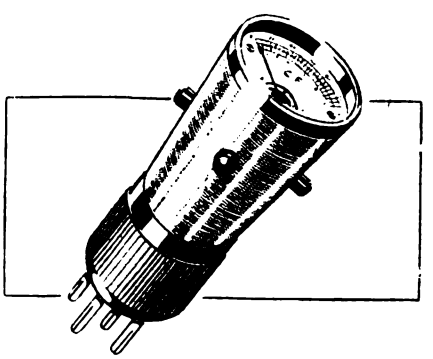
Ferranti grid condenser and leak.

for use following leaky grid detection, there are four eliminator transformers. Type P.10 gives (*a*) 4 volts 4 amps., (*b*) 6 volts 3.2 amps., (*c*) 45 volts at 5 milliamps. This transformer meets the popular demand for converting a set for mains operation. Price 32s. Type E.V.4, giving 250 volts at 50 milliamps when used with the U.5 rectifier. Price 25s. Type P.9, which, with a Westinghouse rectifier type A.3, will give a battery charging rate of 1 ampere, and is suitable for energising the field coil of a moving-coil loud speaker. Type M.3 has been introduced to suit the Westinghouse rectifiers types H.T.3 and H.T.4, and in connection with the condenser voltage doubling arrangement gives respectively 120v. 20 mA. and 180v. 30 mA.

Ferranti, Ltd., Hollinwood, Lancashire.

FONTEYN. (130)

This firm are agents for several French and Belgian manufacturers, and are showing a quantity of apparatus which is of interest as being representative of present-day practice in those countries. The "Radio Controller" is a neat two-range voltmeter mounted on a standard valve base, the pins of which can be inserted in any of the valve sockets of a receiver.



Fonteyn's "Radio Controller": a 2-range voltmeter with valve socket fitting.

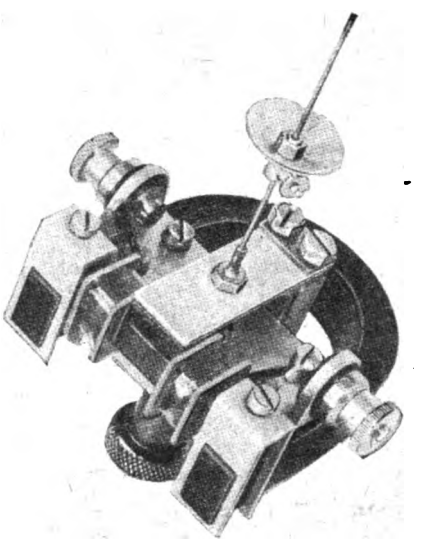
Push-button switches are so arranged that low-tension or high-tension voltages may be checked: of course, the reading of the latter will be affected by the ohmic resistance of whatever coupling component may be connected in the anode circuit, and will only be correct when dealing with a high-frequency amplifier. Nevertheless, any deflection of the needle will show continuity, and an accurate indication of voltage can readily be obtained if the anode coupling component is temporarily short-circuited, should it be of sufficiently high resistance to warrant this course.

A number of inexpensive low-frequency transformers, sold under the trade name of "Cifel" at prices between 3s. 6d. and 8s. 6d., are also exhibited, together with ebonite panels, also exceptionally low in cost.

Messrs. Fonteyn are agents for meters made by the firm of Guerpillon and Sigogne, of Paris, and show a number of these instruments, both of the moving-iron and moving-coil type. There is also a gramophone pick-up supplied complete with adaptor for insertion into a detector valve socket: this instrument is provided with a variable damping control.

Other exhibits include a trickle charger with an indicating lamp acting as a fuse, in which a Westinghouse metal rectifier is used, and also a larger model for service stations. There is also a combined H.T. and L.T. charger with valve rectification, selling at £4 10s. complete.

Fonteyn and Co., Ltd., 2, 4. 5 and 6, Blandford Mews, Baker Street, London, W.1.



G.E.C. Stork loud speaker unit.

G.E.C. (48)

Apart from the new Osram valves which have recently been described in detail in these pages, the principal exhibit is the Screen-Grid Four Portable. The model shown is finished in Cambridge blue, and its equipment includes the use

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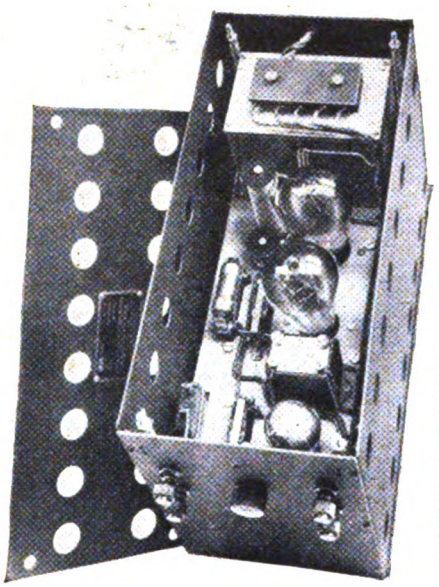
of both screen-grid and generous output valve. This portable is priced £24 3s.

For those wishing to build an inexpensive loud speaker there is the Stork loud speaker unit as fitted in Gecophone loud speakers. An interesting device shown is a power amplifier unit for use with A.C. supply. This is intended for connection to the radio receiver in lieu of an existing amplifier or, alternatively, it will convert a standard gramophone to one of the electrically reproducing type. It is all-metal enclosed and has a particularly generous output valve, the LS6A, while its rectifier is the U.8. This mains-operated amplifier is intended for operating a moving coil loud speaker.



Mains-operated amplifier for use following a detector valve or gramophone pick-up (Gecophone).

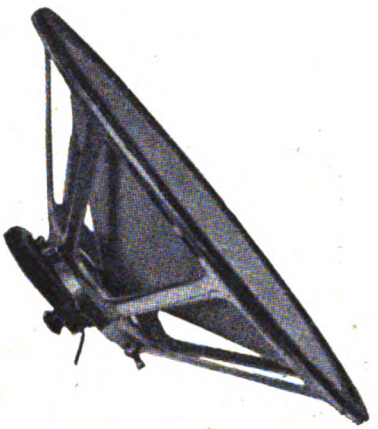
Home constructors are showing a keen interest in the Music Magnet receiver, a detailed description of which recently appeared in these pages.

General Electric Co., Ltd., Magnet House, Victoria Bridge, Manchester. (Magnet House, Kingsway, London, W.C.2.)

GILMAN. (113)

With the help of such labour-saving components as are shown by this company, it is possible for the home-constructor to make a complete loud speaker in a comparatively short time and for a small outlay. There are available two aluminium chassis, one with an 18in. "Power" cone, and another with the standard 11½in. cone, to which can be fixed by three-point suspension a plate so shaped as to be attached easily to all the well-known cone units on the market. The three-point attachment allows perfect centring. The periphery of the metal chassis is drilled to enable the complete unit to be screwed to a baffle or cabinet, and a felt washer is interposed to reduce the chances of resonance. The edge of the cone floats on a supple fabric suspension. The smaller cone unit with adjustable plate sells at 15s. 6d., and the large power model at 22s. 6d.

J. S. Gilman, 63, Basinghall Street, E.C.2.



Gilman 18-inch cone assembly.

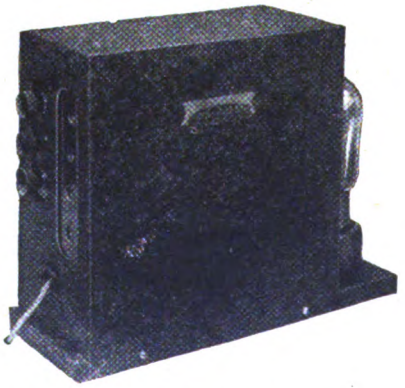
GOLTONE. (16)

As in previous years, a large part of this stand is devoted to radio wire and battery cord assemblies; among the latter is a connecting cable just produced for the Mullard "Orgola" receiver.

The Goltone five-valve portable set embodies a fairly conventional 2-v-2 circuit, but its frame aerial is built into a hinged flap forming a rear cover, so that it can be set for direction without swinging the receiver as a whole.

A combined H.T. and L.T. eliminator has just been introduced. This instrument, which is for operation on A.C. mains, makes use of a Philips double-wave rectifying valve, and has rated filament and anode supply outputs of, respectively, 2½ amps. at 4 volts, and up to 150 volts at 35 milliamperes.

The Goltone radio-gramophone includes a Mullard "Orgola" receiver (A.C. mains model), an electric turntable motor,



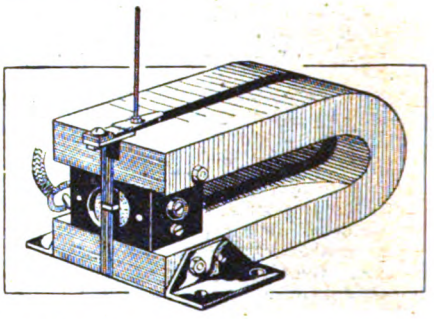
Goltone H.T. and L.T. battery eliminator.

B.T.H. pick-up, and Mullard loud-speaker. There is an extra control for regulating the volume of gramophone reproduction.

Ward and Goldstone, Ltd., Frederick Road, Pendleton, Manchester.

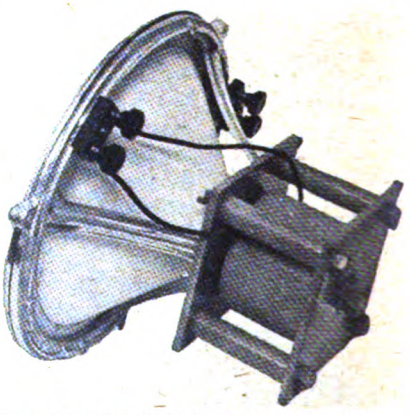
GOODMANS. (84)

Several entirely new models are to be seen, in particular the "Invincible" moving coil loud speaker which follows the end-plate form of construction. By this means it is all-steel built, permitting of high flux density, while the winding is well ventilated. With the use of a particularly small gap and positive centring adequate flux density is obtained when a winding requiring only 50 mA. at 100 volts is used. Such a winding may serve as a smoothing choke.



Goodman balanced-armature loud speaker movement. The adjustable feet provide an easy fixing.

The Goodman differential loud speaker movement is unique in the use of a pair of particularly large magnets of generous cross-section. Four extension poles are presented to the neutral armature, which is surrounded by a 2,000-ohm bobbin. The drive is transmitted to an auxiliary reed. Adjustable and reversible feet



New type Goodman moving coil speaker.

permit of the unit being mounted in a variety of positions to suit most requirements. The price is 29s. 6d.

Goodmans, 27, Farringdon Street, London, E.C.1.

GRAMO-RADIO. (93)

The chief exhibits on this stand, besides a series of radio gramophones, are

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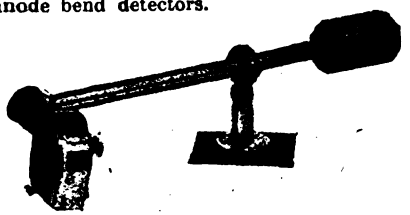
a range of "Coruso" reed-driven cone loud speakers built into attractive cabinets. There are also a number of eliminators for A.C. mains, provided with voltage tappings suitable for the critical requirements of screened valves and anode bend detectors.



Gramophone tone arm with adjustable balance weight, shown by Gramo-Radio Co.

A gramophone pick-up and tone arm with adjustable balance weight which can be locked, should assist in reducing record wear.

Gramo-Radio, Ltd., Commercial Works, Church, Accrington.

GREEN and CO. (75)

A range of Sure-a-lite dry batteries is shown on this stand. High-tension units are made in four capacities, the largest being capable of supplying currents up to 25 mA. Grid bias batteries of conventional dimensions are manufactured, as well as units with voltages up to 30, in square form, which are more economical of space, and consequently suitable for mounting inside the cabinet of receivers with high-power output valves demanding a considerable negative bias.

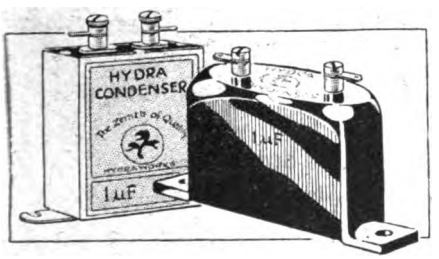
The new Telsen L.F. transformers, described in our Olympia Show Report, are also exhibited, as are several well-known sets in which these components are included as standard.

There is also a display of the new Cleartron valves with improved coated filaments.

Green and Co., 94-96, Hurst Street, Birmingham.

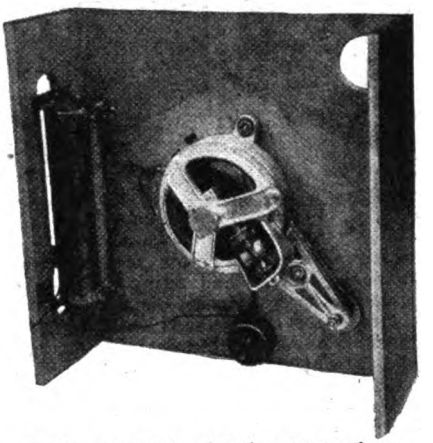
HOLZMAN. (57)

With the large stage amplifications now obtainable with screen-grid valves, it is becoming more and more evident that condensers to be used in decoupling schemes must have a low high-frequency resistance, that is to say, a good power factor. Thus, it is interesting to note that this firm are showing a range of Hydra paper-dielectric condensers with capacities from 0.001 to 4 mfd. with non-inductively arranged foil. In bakelite cases and with a working voltage of 240 D.C., the price of the lowest capacity condenser already referred to is 1s. 6d., while the 4-mfd. type is 5s. Where surge voltages considerably greater than the nominal voltage of the supply mains are encountered, particularly in D.C. eliminators, the Hydra series of condensers tested at 1,000 volts D.C. for an A.C. working voltage of 300 should find considerable application. The 2-mfd. condenser of this type retails at 4s. 9d.



(Left) One mfd. Hydra condenser in metal case. (Right) Non-inductive condenser in bakelite case (Holzman).

There is being shown a vertical scale double-reading volt-milliameter. It is a moving coil instrument with a resistance of 250 ohms per volt and the scale readings are 0-240 volts and 0-60 mA. Besides having a minimum projection from the front of the panel, the meter should harmonise with thumb control tuning dials. The price is 22s. 6d.



Insol universal electric gramophone motor, shown on Holzman's Stand.

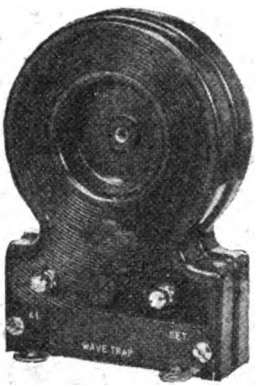
The Insol gramophone motor and turntable for A.C. mains contains a squirrel-cage motor which runs at 1,750 r.p.m. The drive is by rubber belt from a tapered spindle, and the speed is made variable by ±6 r.p.m. by means of a control which causes the belt to run on a larger or smaller diameter of the taper. It is claimed that the running is particularly silent. The price is £6. There is also a universal model for D.C. or A.C. supplies

Besides tapped condenser blocks, which it is now appreciated are more economical where eliminator smoothing filters are concerned, there is being marketed a double buffer condenser of 2×0.1 mfd. for shunting across the secondary of a mains transformer. Tested at 1,000 volts A.C., this component sells at 3s. 3d.

Louis Holzman, 37, Newman Street, W.1.

IGRANIC. (50)

New components introduced since the opening of the Olympia Exhibition include a wavetrap, of which the coil and variable condenser (the latter of the compression type) are built into a brown bakelite moulding provided with feet so that it may be secured to the baseboard of an existing receiver.

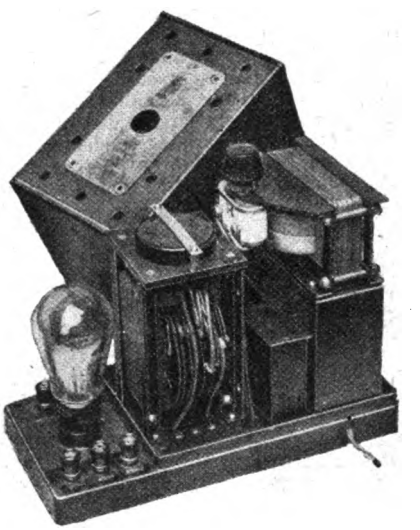


Igranic wavetrap.

The "Megastat" variable high resistance has been modified to render it more suitable for mounting in radio gramophones or for controlling volume in sets fitted for gramophone reproduction; it is now available in types having maximum values of 50,000 ohms, 500,000 ohms, 1 megohm, and 5 megohms.

Indigraph vernier dials are now fitted with a reduction gear giving a ratio of 15 : 1; the 4in. pattern has a slightly higher ratio.

A new battery charger, incorporating the Igranic-Elkon metal rectifier, has been introduced; it delivers current up to 3 amps. The same rectifier, working in conjunction with an electrolytic condenser, is used in an L.T. supply unit, which is suitable for supplying up to seven valves rated at 4 or 6 volts. Valve rectification is included in the new Igranic H.T. unit, which also supplies



Igranic H.T. eliminator, which also supplies current for the heating elements of A.C. valves.

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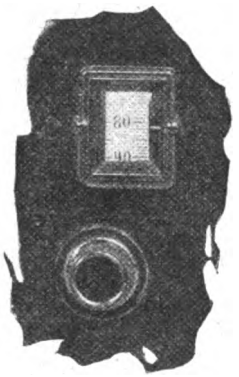
raw A.C. at 4 volts for feeding the heaters of A.C. valves.

The "Q.M.B." switch is intended for mains-fed receivers; it has wide-break contacts, heavy insulation, and an ebonite control knob.

Igranic Electric Co., Ltd., Elstow Works, Bedford.

ISOMONO. (106)

A wide range of "Iso" dials are exhibited on this stand, including several new models. Some are provided with a catgut band drive, and several patterns have an illuminated scale; in one case the lamp is controlled by a neat and inconspicuous switch forming part of the



A neat Isomono drum dial with knob control.

escutcheon plate. These dials are manufactured in both drum and disc types, double and single, and their appearance when fitted is in keeping with modern tendencies.

There is also a very wide selection of imported components at most attractive prices. One of the most interesting is a wire-wound potentiometer of 30,000 ohms resistance, selling at 6s. 3d. This should be most useful in regulating eliminator voltage output, particularly for screen-grid valves.

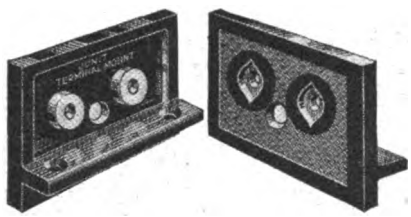
Wave traps are coming into prominence, and for the more efficient type it is customary to use a small inductance and a comparatively large value of tuning capacity. As variable condensers of more than 0.0005 mfd. are not readily obtainable, it is convenient to add a fixed shunt capacity, and the air dielectric components shown by this firm would appear to meet the case admirably. They are made in capacities of from 0.00005 to 0.001 mfd., and are extraordinarily compact and but little more expensive than the better type of mica-dielectric condensers.

Other components on show are chokes, power transformers, very small condensers, both with air and paxolin dielectric, fixed condensers, and trickle chargers with Kuprox rectifiers selling at 30s.

Haw and Co., Ltd., 20, Cheapside, London, E.C.2.

JUNIT. (70)

A neat push-pull switch for metal panels is being shown. The spindle contains two bow-springs, which ensure good electrical contact without unduly impeding the movement of the plunger. There is another model available, in



The Junit vertical terminal mount with horizontal fixing flange.

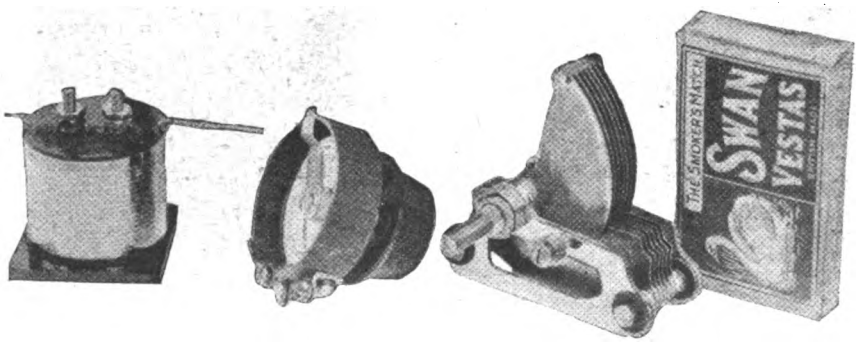
which all contact points are insulated from the spindle and fixing bush. The price of these switches, one of which is specified for the Mullard Orgola set, is 1s. 6d. A vertical terminal mount, sold at 8d., which has a right-angled drilled flange, is arranged to screw into the horizontal surface of a baseboard, and thus the danger of splitting is avoided.

There is also a universal 5-pin valve holder and a multiple contact switch.

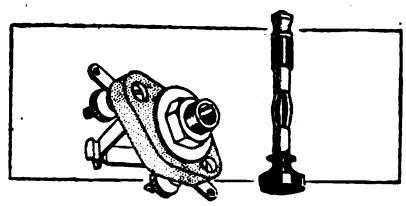
Junit Manufacturing Co., Ltd., 2, Ravenscourt Square, W.6.

KOLSTER-BRANDES. (74)

For the new season this company has embarked upon the manufacture on a large scale of popular-priced receivers. As an example, the K-B 161 can be said to give good value for money. It is a 3-valve receiver entirely driven from



Some compact components shown by Haw & Co. From left to right: air-dielectric fixed condenser, 30,000 ohm potentiometer, and 0.0003 mfd. variable condenser.



Junit push-pull switch. Note the bow-springs on the spindle.

A.C. mains. A double-tuned circuit is employed, which makes for good selectivity, and greater sensitivity is obtained by the use of reaction on to the secondary of the high-frequency transformer, which links the AC/SG valve to the leaky grid detector. On the low-frequency side there is a transformer coupled pentode, the filament of which is heated by raw A.C. The set is well screened and decoupled. The feed to the screen of the SG valve is through a potentiometer, which is in keeping with the best practice. A valve rectifier is used for the anode supplies and the "free" positive grid bias is obtained from a potentiometer across the H.T. Thumb controls are used and the receiver is housed within a well-finished oak cabinet. The price is £17 10s., including valves and royalties.

K-B 163 receiver; a Kolster-Brandes product at a popular price.

A battery model (the K-B 163), on the same lines, sells at the moderate figure of £10 15s. complete.

Kolster-Brandes, Ltd., Cray Works, Sidcup, Kent.

LOTUS. (31)

A carefully prepared folder showing the construction of the Lotus S.G.P. receiver is attracting interest. Its large constructional drawings show in precise detail the building of a well designed three-valve set. Wiring is simplified by full scale drawings showing the bending of every lead. The circuit is in every way up to date, including all those refinements appreciated by the enthusiast.

Garnett, Whiteley and Co., Ltd., Lotus Works, Mill Lane, Liverpool.

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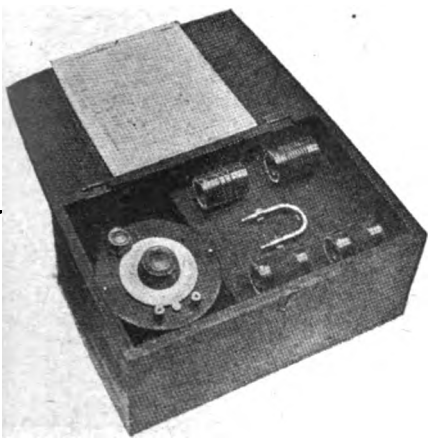
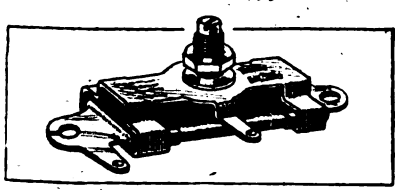
CLAUDE LYONS. (35)

The products exhibited at this stand principally include specialised components for the transmitting amateur, practical laboratory test gear for the manufacturer as well as generous amplifier equipment. The apparatus is mainly that of General Radio, together with a selection of components from the American market.



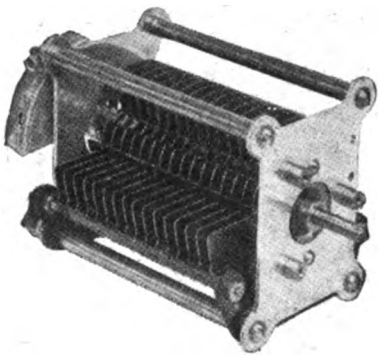
General Radio frequency meter on the stand of Claude Lyons, Ltd. This model has been specially introduced to meet the Post Office requirements governing the issue of transmitting permits.

For the transmitting amateur faced with the difficulties of conforming to Post Office requirements a special type of absorption wavemeter has been introduced. This instrument, type 558P, has



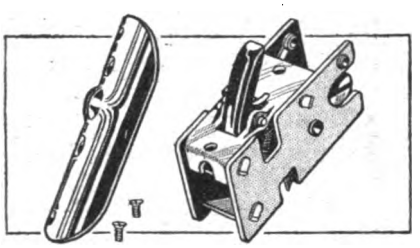
The "Hum Dinger" an adjustable potential divider for use in the construction of mains-operated sets. Shown on the stand of Claude Lyons, Ltd.

been approved by the Post Office, and will, in use, permit of an accuracy greater than the stipulated ±0.25 per cent. Its five scales have optimum frequencies of 5, 10, 20, 40 and 80. The price is £5. This instrument includes a special condenser which is also available as a com-



General Radio transmitting condenser. The losses have been reduced to a minimum to permit of its use on very short wavelengths. (Claude Lyons, Ltd.)

ponent. By arranging for only a few of the plates of this condenser to produce a change of capacity it gives a particularly open scale over a limited range while maintaining a suitable L/C ratio. For the transmitting enthusiast also special condensers are shown primarily designed to



A useful catch switch for breaking the supply circuit on opening a mains connected receiver. (Claude Lyons, Ltd.).

possess minimum losses at the ultra high frequencies. These are specially intended for use in transmitting circuits, and are available in three capacities, 0.00005 mfd., 0.0001 mfd., 0.00025 mfd., the last mentioned selling at 35s.

Small components include Centralab and Clarostat products, while among bigger equipment is a specimen Pam speech amplifier.

Claude Lyons, Ltd., 76, Old Hall Street, Liverpool.

M.P.A. (21 and 22)

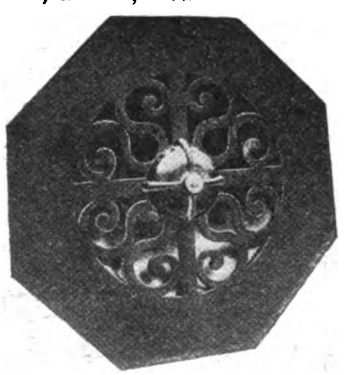
The "Ethatrope Exchange," an ambitious radio-gramophone combination, may perhaps best be described as a "next year's set." It includes an ingenious arrangement whereby a series of circuits tuned to any one of four stations—chosen by the purchaser—may be put into operation by manipulation of the appropriate switch. There is clear evidence that this simplified method of tuning already appeals to many listeners, and it is bound to be still more popular when the new scheme of alternative programme transmissions comes into being. It may be urged that the buyer of a comparatively elaborate set will think himself justified in demanding a wider choice of stations; this objection is adequately met, in the case of the receiver in question, by providing a switch for disconnecting the automatic tuning device, thus allowing of operation in the normal manner.

Indirectly heated valves are fitted in this set, which is intended for an A.C. supply; the variable condensers tuning the circuits associated with its two H.F. couplings and the frame aerial are completely "ganged." The detector is followed by two L.F. stages, with parallel output valves. A moving coil loud speaker is built into the base of the large gramophone-style containing cabinet, which also accommodates the medium- and long-wave frame aerials; these are mounted at right angles, the whole assembly being rotated by means of an edgewise drum protruding through the side.

Provision is made for connection of one or more external loud speakers, and a microphone can be used for addressing large audiences.

The new A.C. transportable sets are completely self-contained except for a connection to an electric supply. Four indirectly heated valves, including one high-frequency amplifier, are used.

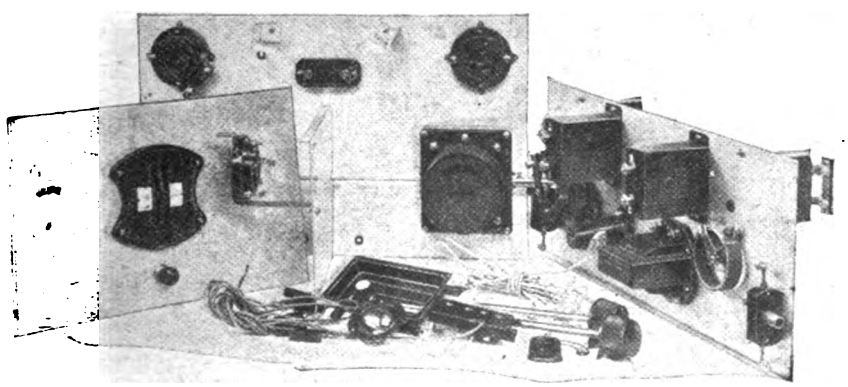
M.P.A. Wireless, Ltd., High Road, Chiswick, London, W.4.



New Marconiphone Octagon cone loud speaker.

McMICHAEL. (54)

As at Olympia the McMichael "Super Range Portable Four" is the principal



Garnett Whiteley Kit Set. The components are supplied assembled as shown here so that the constructor is only required to carry out the wiring.

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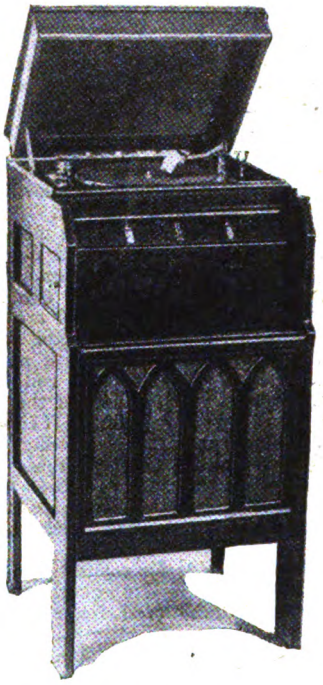
exhibit here. An exposed chassis shown at this stand reveals the interior construction which, to those who are acquainted with the performance of this set, satisfies the inducement to carefully study the principles involved.

L. McMichael, Ltd., Danes Inn House, 265, Strand, London, W.C.2.

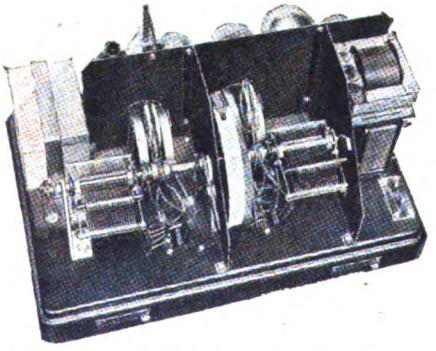
MOORES. (8)

An interesting exhibit on this stand is a radio-gramophone including a Philips Type 2514 receiver—an H.F.-det.-pentode all-mains set for operation on an A.C. supply, with which many readers will be



Moores' radio-gramophone cabinet, which includes a Philips set.

familiar The gramophone turntable is rotated by a Garrard double-spring motor, and an external volume control is provided. A cone loud speaker is built into



Pressed metal chassis of the Marconiphone Model 47 A.C. receiver.

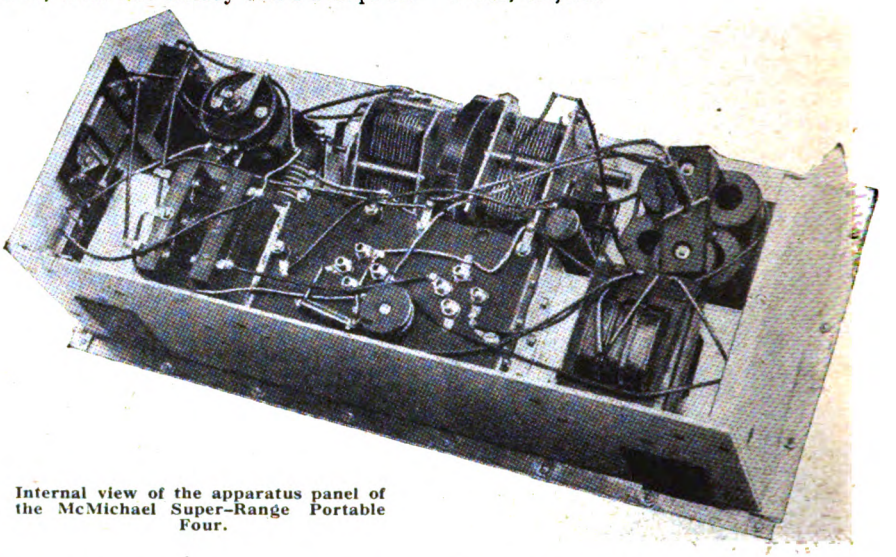
the base of the cabinet; an Ormond instrument is customarily fitted, but any other pattern can be supplied to order.

This instrument is sold complete at £45; those who already own a Philips set may obtain the cabinet ready wired and fitted in such a way that the receiver may be mounted in position and connected up by the veriest novice; this fitted gramophone cabinet costs £22 complete—except, of course, for the receiver itself.

Upright cabinet for Philips' 3-valve A.C. set shown by J. Moores and Co.

Another upright cabinet, of similar design but of reduced depth, is arranged to take the above-mentioned Philips set, but has no gramophone turntable. There is ample room in the base for any make of cone loud speaker.

J. Moores and Co., Ravald Street Works, Salford.

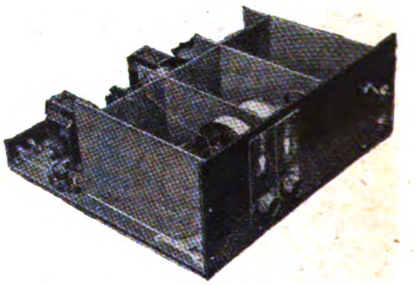


Internal view of the apparatus panel of the McMichael Super-Range Portable Four.

NORTHERN STEEL and HARDWARE CO., LTD. (104)

Wholesale distributors to the trade of the products of well-known manufacturers such as Philips, Marconi, Mullard, Amplion and Cossor. A representative range of receivers, loud speakers, and eliminators is to be seen on this stand.

Northern Steel and Hardware Co., Ltd., 1-3, Southgate, Deansgate, Manchester.



Mullard Orgola Senior receiver.

OLDHAM. (43)

While having been described in detail when they were exhibited at Olympia, mention might again be made of the Oldham auto-power units. These instruments function as L.T. and H.T. battery eliminators, but are, in fact, batteries that are automatically recharged. They can, therefore, be used with any receiving set without trouble or complication. Units are available for use with A.C. or D.C. supply, and their adoption renders a set virtually all-mains operated.

Oldham and Sons, Ltd., Denton, Manchester.

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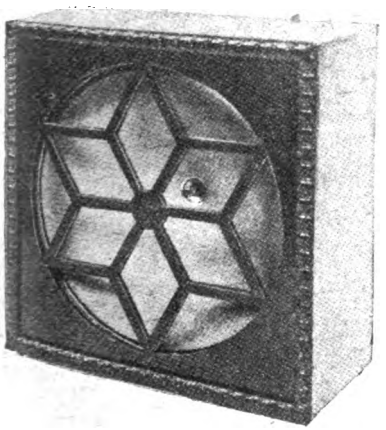
ORPHEAN. (6)

The chief products of this company are cone loud speakers. The smaller speaker, housed within a cabinet 11in. square, contains a 9in. cone partly concealed by an oak grille; it is marketed at the popular price of 30s. Another model embodies a 9in. cone attached at its periphery to a square bakelite plaque with a burr walnut finish. The whole speaker is so constructed that it can hang from the picture rail or stand on the table. The price is 29s. 6d.

A plug and jack connector for loud speaker connection in a house wiring scheme is exhibited; it has the advantage that the insertion and withdrawal of the plug is nearly parallel and not at right-angles to the wall of the room. This renders the whole component inconspicuous.



Orphean popular cone speaker. (London Radio Manufacturing Co.).

London Radio Mfg. Co., Ltd., Trafalgar Works, Station Road, Merton Abbey, S.W.19.

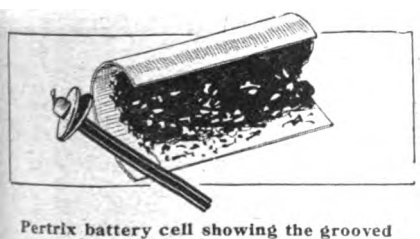
PERTRIX. (37)

It can safely be said that the percentage of listeners who have an electric lighting supply in their houses is below 25; the number of sets, therefore, still relying on batteries for their anode supply must be exceedingly large. The special depolariser and electrolyte used in the Pertrix batteries is said to prevent chemical action from continuing after the load is removed; furthermore, it is claimed that as the cells drop in voltage the internal resistance does not rise, this state of affairs being brought about by the hardening of the depolariser, which does not increase its resistance with age.

There is a representative range of radio batteries exhibited from the 9-volt bias type to the heavy-duty H.T. batteries capable of giving a 30 milliamp. discharge. The 60-volt battery of the popular type, selling at 8s., has been tested in *The Wireless World* laboratories and found to have a useful life of about 470 working hours when the initial discharge is 8 mA.

A feature of interest, especially in connection with portable sets, is the provision of a number of 1½-volt tappings at the negative end to enable grid bias to be taken from the H.T. battery.

Pertrix, Ltd., Britannia House, 233, Shaftesbury Avenue, W.C.2.



Pertrix battery cell showing the grooved carbon and sacless depolariser.

PETO-SCOTT. (45)

This firm, which specialises in the supply of complete sets, kits of parts, and accessories, either for cash or on the deferred payment system, are showing a singularly well-chosen assortment of the better makes of apparatus.

There is also to be a kit of parts for an ambitious six-valve receiver with three tuned H.F. stages. Although a complete model had not arrived at the time of visiting the stand, the chassis assembly of four variable condensers for this set was examined with great interest. Each condenser is rotated individually by means of its own control knob, but all are coupled together through worm gearing so that they may be operated simultaneously; there is a slipping clutch fitted to each condenser spindle. This is a promising development of the semi-gang control principle, and is obviously applicable to any set with two or more tuned circuits.

Peto-Scott Co., Ltd., 77, City Road, London, E.C.1.

Philipson A.C. battery eliminator. It has a valve rectifier, while terminals are provided for supplying current to indirectly heated valves.

PHILIPSON. (123)

The activities of this company are devoted exclusively to the production of H.T. battery eliminators for use with A.C. and D.C. supply. It is understood that the various voltages are obtained by the potential dividing method, while the A.C. models adopt valve rectification. These eliminators are well finished and all-metal enclosed and sell at popular prices.

Philipson and Co., Ltd., Astley Bridge, Bolton.

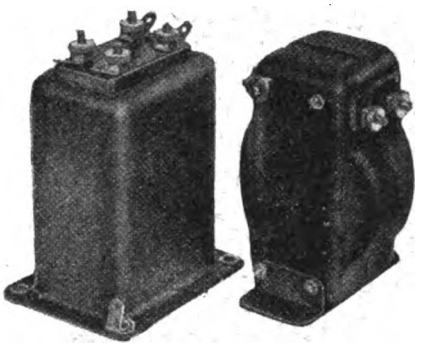
POTTER. (62)

Manufacturers and wholesalers of ebonite sheet, known as "Parfait." Moulded ebonite to various requirements can now be undertaken on a new plant just installed. Ebonite sheet is being shown with six different surfaces, namely, matt, black, polished various mahogany finishes, and a cube surface.

H. B. Potter and Co., Ltd., Station Buildings, Rochdale.

PYE. (51)

The Pye radio-gramophone, of which details were not available for our Olympia Show Report, is an interesting example of modern practice. It is an A.C. mains set with two H.F. stages (one tuned and one aperiodic), and a detector followed by resistance- and transformer-coupled L.F.



New Pye L.F. transformers.

amplifiers. The apparatus is completely self-contained (except for a mains connection), the internal frame aerial being rotated by a knob mounted near the record turntable. There is a "local station damper," and the built-in loud speaker is of the moving coil type.

Pye receivers, Type 460 and Type 350—the first for batteries or D.C. mains and the second for A.C. supplies—have already been described, and are well worth examining, if only because they go to prove that up-to-date high-efficiency circuit arrangements can be embodied in sets produced on a manufacturing basis.

A National Physical Laboratory curve is issued with respect to the new low-priced Pye L.F. transformer, and shows an exceptionally good performance for a component sold at only 12s. 6d. Another transformer with a mu-metal core, has a shroud of the same material which, it is stated, is effective in preventing induction troubles, particularly in all-mains receivers.

Pye Radio, Ltd., Paris House, Oxford Circus, London, W.1.

RADIOVIM. (94)

This company operates a battery hire and maintenance service, and delivers low- and high-tension accumulators to residents within ten miles of either Manchester or Liverpool. Full details of the service are given in a booklet issued on the stand; as an indication of cost, it may be stated that a freshly charged 30

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ampere-hour two-volt cell is supplied once a fortnight for a shilling.

Radiovim, Ltd., Sandford Street, Ancoats, Manchester, and 24, The Elms, Dingle, Liverpool.

REDFERN. (24)

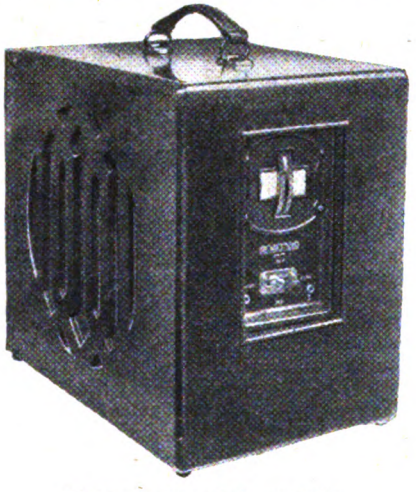
Two new types of ebonite coil formers have been introduced since the Olympia Exhibition. One of these has a mean external diameter of 3in. with nine deep ribs (approximately ¼in.), and, as in the case of the earlier 6-ribbed product of this firm (which, by the way, is still available), is particularly suitable for use in the construction of section-wound coils of almost ideal proportions; the extra ribs make for easier winding and for a better looking and slightly more efficient coil.

There is also a new former with a diameter of 2½in. and six ribs.

Redfern's Rubber Works, Ltd., Hyde, Cheshire.

RIALTON. (117)

The Melva transportable 5-valve receiver contains an interesting and unconventional circuit. There are three



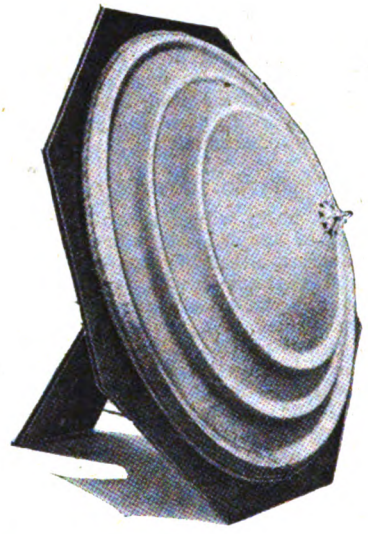
Rialton 4-valve S.G. portable.

screen-grid valves in a modified superheterodyne arrangement, whereby a good measure of H.F. amplification is got without the necessity of elaborate screening. The first screened valve acts as a separate oscillator and the second and third valves are coupled as intermediate frequency amplifiers with aperiodic transformers. There is only one detector, which is coupled to a pentode output valve. The S.G. portable set, selling at 19 guineas, is extremely compact, and is one of the smallest 4-valve sets on the market. Its dimensions are 15in. × 9in. × 10in. The first valve—a screened valve—is aperiodically choke-coupled to a triode which in turn is aperiodically coupled to the leaky grid detector. There is one L.F. valve—a pentode. The set is well finished in polished grained oak, and has a small recess on one side in which the drum dials are placed.

Rialton Radio, 21A, Barbican, E.C.1.

RIDGED CONE COMPANY. (96)

A complete reed-driven cone loud speaker at 25s. and its two essential components—the magnetic unit and the fabric cone—are being exhibited on this stand. The cone, which is seamless and sells at 3s., has three prominent ridges, which it is claimed assist in strengthening and allow the cone to vibrate as a whole over the normal range of frequencies.



Cone assembly by the Ridged Cone Co.

The "R.C." unit, selling at 13s. 6d., has four large magnets with laminated poles and an adjustable reed. The D.C. resistance is 2,000 ohms. The twin-transmission regional scheme will demand the cutting down in length of outside aerials; in fact, in a great many cases it will probably be necessary to use indoor aerials. With this in view the Ridged Cone Company have produced a number of complete indoor aerial equipments with insulators, etc., selling at popular prices.

Ridged Cone Co., Ltd., York House, Southampton Row, W.C.1.

RITHERDON. (108 and 109)

Metal cabinets constructed on the lines suggested by contributors to these pages are exhibited by this firm. A container for *The Wireless World* Kit Set is a replica of that used in the original model, and is of suitable size to accommodate any of the conventional H.F.-det.-L.F. circuits. Channels are provided along the lower edges of the metal cover, and are arranged to engage with strips forming part of the base. This affords a good electrical joint, as, thanks to careful workmanship, all clearances are small. Sealing should be sufficiently good for any type of circuit likely to be set up in this size of cabinet.

A similar method of construction is employed in building the larger type of cabinet used for the Kilo-Mag Four, Record III, and 1930 Everyman Four sets. Due to the fact that the screening cover is considerably larger, and has three crosswise partitions, clearances of the base joints are of necessity somewhat larger, and in cases where an exceptionally high magnification is aimed at it might be necessary to provide additional sealing, say by placing lengths of springy metal braid in the channels.

These cabinets are thoroughly well made, and the metal work is nicely finished in rosewood, walnut, dark oak, or imitation leather.

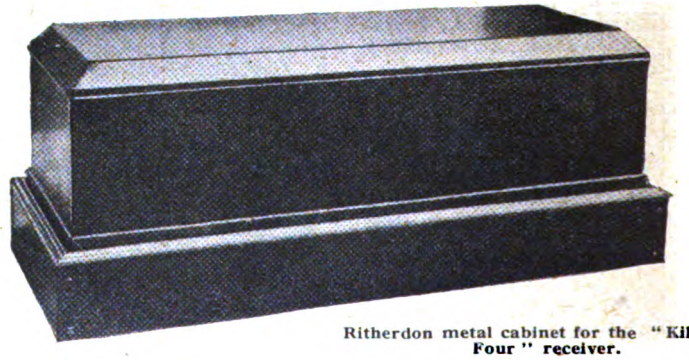
The large and small containers cost, respectively, £2 6s. 6d. and £3 in wood finish, and a few shillings less in imitation leather.

A large number of other metal containers are exhibited, including a neat inexpensive box with a horizontal partition, which would be suitable for a two-valve all-mains receiver.

Ritherdon and Co., Ltd., North Bridge Mill, Deansgate, Bolton.

ROYAL RADIO. (86)

A mains-operated three-valve transportable receiver (H.F.-det.-L.F.) has been introduced since the Olympia Show.



Ritherdon metal cabinet for the "Kilo-Mag Four" receiver.

This set includes a built-in loud speaker and frame aerial, and has provision for a gramophone pick-up. An external aerial may be used if desired. Models for A.C. or D.C. supplies are each priced at 28 guineas.

All the receivers shown at Olympia are available, and the radio-gramophone has been improved by fitting a moving coil loud speaker.

Royal Radio Company, 4 and 5, Dorset Mews North, Upper Gloucester Place, London, N.W.1.

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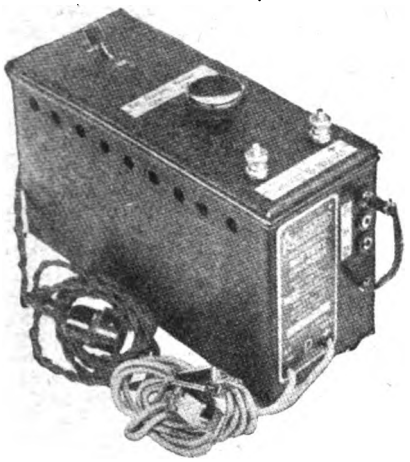
RUNBAKEN. (127)

In view of the increasing interest in radio-from-the-mains, the series of automatic and semi-automatic battery chargers and testers exhibited should have considerable appeal.

The Ardwick charger contains a vibrator rectifier and, for H.T., sells at 49s. 6d. A charging rate as high as 350 mA. can be maintained. The combined L.T. and H.T. instrument is marketed at 95s., and is capable of giving 3 amps. at 6 volts. It should find application to car as well as radio accumulators. The automatic charger for A.C. is designed to remain permanently in circuit with the mains supply, the set and the L.T. accumulator. As soon as the radio set is switched off, the charger automatically comes into



Runbaken automatic charger.

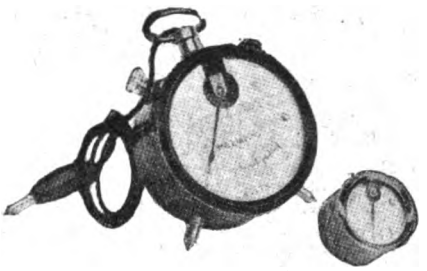
action, and vice versa. The battery is thus kept in a healthy condition by reason of the taper charge given to it. The price is 75s. A semi-automatic type, which is not interposed in the L.T. switch circuit of the set, costs 65s. There is a variety of chargers with dry copper-oxide rectifiers.

An unbreakable hydrometer in which the float-spindle is guided by a thin horizontal drilled washer to prevent surface tension effects with the inside wall, should provide a means of measuring specific gravity accurately. Battery testers to give reliable results should first place a load across each cell before reading voltage. In fact, the best indication of the state of charge is obtained by noting the no-load to full-load voltage ratio. With the Runbaken tester a 12-amp. load is taken from small accumulator cells, whilst for car starting batteries experience shows that a cell is in good condition if it reads 1.5 volts at a load of 200 amps. This company is also showing loud speaker and telephone magnetisers.

Runbaken Magneto Co., Tipping Street, Ardwick, Manchester.

SIFAM. (11)

A new pocket volt-milliammeter with ranges suitable for the average domestic receiver and selling at 10s., should prove of interest to readers. The 15-volt range is for L.T. and bias measurements, while the 150-volt and 50 mA. scales will cover normal anode requirements. There is available a new range of baby meters for

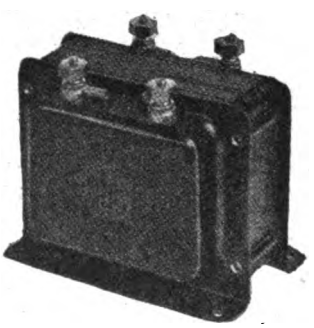


(Left): New Sifam pocket volt-milliammeter. (Right): Miniature milliammeter measuring only 1in. diameter.

flush mounting, which measure in diameter only one inch. It is remarkable that such a large amount of material can be got into such a small space. There are only ammeters and milliammeters in this series with centre-zero marking for charging purposes. The price of each model is the same, namely, 7s. 6d.

A new moving coil meter, with knife edge pointer, is being put on the market, and there is also available a hot wire instrument especially suitable for measuring heater voltages for indirectly heated cathode valves. For valve filament protection a new type of radio fuse is being shown. The fusing points are from 150 mA. to 6 amps.; they are sold at 1s. 3d. and 1s. The eliminator voltmeter with a resistance of 100,000 ohms, and known as the "Elimeter," is being retained for the coming season.

A 3 to 1 L.F. transformer, called the "Hevicore," and selling at 17s. 6d., is among the exhibits; it is stated to be suitable to follow valves having an impedance not exceeding 25,000 ohms.



Sifam "Hevicore" L.F. transformer.

Besides the special meters referred to, there is a comprehensive display of moving coil and moving iron meters with conventional scale readings; there is, in fact, on this stand a meter for every radio purpose.

Sifam Electrical Instrument Co., Ltd., Bush House, Aldwych, W.C.2.

SINQUERS. (124)

Long life from accumulators is only obtained if careful attention is paid to maintaining the specific gravity of the electrolyte at the correct value. Charge indicators showing a rough value of the acid density are provided by specially constructed pellets known as "Sinquers," the red and blue coloured varieties of which sink at different states of discharge of the cell into which they are dropped. A pellet of each colour dropped into a fully charged accumulator will float on the surface of the acid, but if the cell is half discharged the red ball only will float, while the blue will sink. Should both balls sink the battery requires an immediate charge.

Fiddian, Bawtree and Co., Gem Works, Oakhill Road, Sutton, Surrey.

Six-Sixty power output valve.

STANDARD INSULATORS. (71)

A new material for panels has just been introduced by the Standard Insulator Company. It consists of a bakelite base coated on each side with a veneer of wood—birch, walnut, or mahogany—the whole being subjected to a bakelising process which imparts a highly finished glossy surface, and, what is perhaps more important, improves its electrical properties. It is stated that panels can easily be drilled, tapped or machined, and specimens on the stand show that it can be engraved in the ordinary manner.

In appearance, these panels are indistinguishable from real wood—indeed, there is no reason why they should be, as the visible part is actually wood. The new material is known as Hivoltsit Veneer Bakelite, and is stated to withstand an average pressure of 13,000 volts per millimetre thickness. Its resistance per cubic centimetre is given as 1.48×10^{12} ohms. It seems probable that these panels will find a ready application, particularly in the construction of high-grade receivers where good appearance is considered to be essential.

The Standard Insulator Co., Ltd., Winsley House, Wells Street, Oxford Street, London, W.1.

STOTT. (125)

The "Pegasus-Scout" portable receiver, of more or less conventional design, should have a performance well above the average: its layout is exceptionally neat

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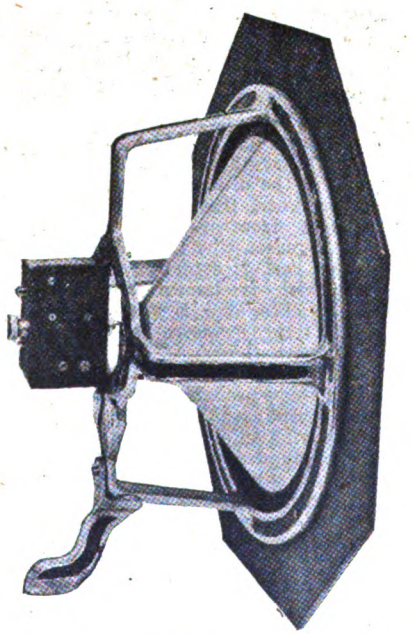
and workmanlike, and all the components used in its construction are of high grade. Its anode circuits are decoupled—a refinement not yet by any means universal in sets of its class—and in consequence there is but a single positive lead to the H.T. battery.

The Pegasus portable receiver with back cover removed.

Provision for a gramophone pick-up is included, and an upright cabinet with grille front, turntable, pick-up arm, and space for the receiver is also supplied, in order that the set may be converted into a radio-gramophone. The fitted cabinet costs 13 guineas, while the receiver itself is priced at 17 guineas.

This firm are Northern agents for the Mic Wireless Co., of Wellingborough, and are showing specimens of the new "Zampa" components and accessories described in our Olympia Show Report.

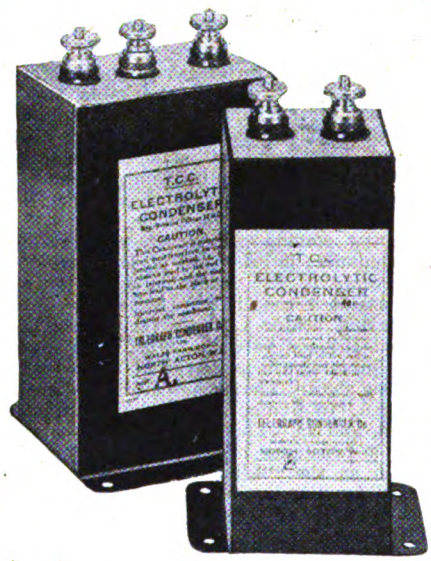
J. E. Stott, 15, *Clare Hill, Huddersfield.*



The Squire aluminium cone cradle. This is exhibited as an octagonal hanging lamp shade with bead fringe.

T.C.C. (83)

In addition to the wide range of fixed condensers for every purpose in a radio set, there has been introduced this season a single type electrolytic condenser for a maximum working voltage of 40; the minimum capacity is 500 microfarads, and the price £1. The electrolytic condensers shown are of the dry polarised type, and must be connected to the correct poles. The importance of good power factor, especially in condensers which have to by-pass H.F. energy in a divided circuit, is not being overlooked by this company, who are spending much time in research on non-inductive connection of condenser foils.



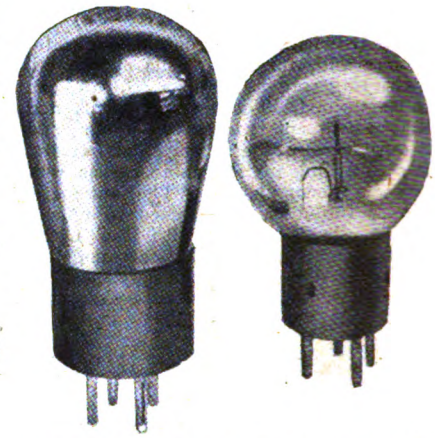
T.C.C. electrolytic condensers for L.T. eliminators.

A range of tapped condenser blocks for eliminators is to be seen on this stand. The company are to be congratulated on having been chosen by the B.B.C. to supply a number of high-voltage smoothing condensers for the new station at Brookman's Park.

Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, W.3.

TUNGSRAM. (10)

Pamphlets available at the stand give complete technical data of the valves made by this well-known lamp manufacturing concern. Among the details given it is interesting to note the inclusion of anode conductance (reciprocal of impedance) as well as power output in milliwatts. While the range of valves is very extensive, it does not, as yet, include the screen-grid and pentode types. As a gauge to the performance of these valves one might take a typical L.F. type such as the P.215. Passing 0.15 ampere at 2 volts it has an amplification factor of 5 with an impedance of 3,300 giving a mutual conductance of 1.5 mA/v. Among 6-volt power valves there are the P.615 and P.614. The former has an amplification factor of 10 with an impedance of



Specimen Tungsram power valve and photocell.

3,300 ohms, and the latter an amplification of 6 with an impedance 1,900, so that the mutual conductance in each case reaches the high figure of about 3 mA/v. These valves are priced at 7s. 3d. and 8s. respectively. The range includes directly and indirectly heated valves for use with A.C. supply. As an example in this class we might take the general-purpose valve A.G.4100. Like other valves the heater unit takes 1 ampere at 4 volts, and the amplification factor is 16 with an impedance of 8,000 ohms, giving a mutual conductance of 2 mA/v. The price of this valve is 8s. 6d.

Much interest is now being taken by amateurs in the experimental use of photocells, and shown at the stand is the Tungsram "Nava" cell. It is a sodium cell of the hard variety, and is therefore stable. An interesting feature is the provision of a filament within the cell. This is used in the process of forming the sodium coating, though in normal use the filament is not heated, but is used as an anode. The wavelengths of light to which this cell responds represent a band between violet and orange, while another cell is available covering the spectrum from the blue to the red. The prices of these cells are 50s. and 57s. 6d. respectively.

Tungsram Electric Lamp Works (Great Britain), Ltd., 72, Oxford Street, London, W.1.

TUTILL. (14)

There are several new and interesting products to be seen on this stand. Perhaps the most ambitious is the "Tinol" radio-gramophone, which is supplied for operation on A.C. or D.C. mains. It includes a five-valve receiver working with an external aerial, with one high-frequency valve, detector, and two L.F. stages with push-pull output. The two circuits are tuned by a Utility balancing condenser, reaction control is on the differential principle, and there is

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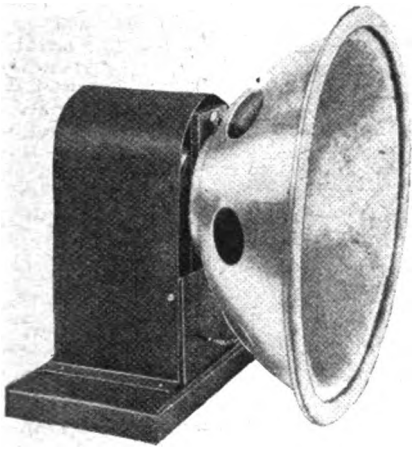
a volume control operative on both radio and gramophone reproduction.

An unusual refinement is the provision of a tone control; with the regulating lever at the normal position no correction is applied to the amplifier, but movement to either side introduces a degree of attenuation of the bass or treble as may be desired.

This instrument is fitted with a moving coil loud speaker, and is supplied either in a walnut or mahogany cabinet at £65 for A.C. and £55 for D.C. supplies. Extensive precautions are observed towards the prevention of low-frequency reaction.

In spite of its extremely low price—the battery and D.C. models cost but £2 19s. 6d.—the Liberty moving coil loud speaker is well constructed and designed on sound lines. An easily adjusted paper "spider" is provided for centring, and the cone is supported by a surround of closely woven fabric, stated to be unaffected by climatic changes. As a step-down transformer is mounted in the base the instrument as supplied is complete and ready for mounting in a cabinet or on a baffle board. An A.C. model, with Westinghouse rectifier and electrolytic smoothing condenser, is sold for £5 15s.



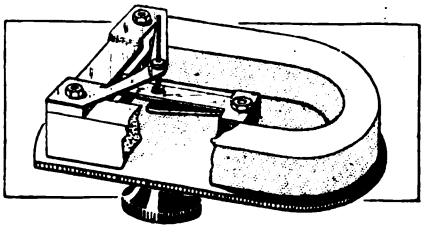
The Liberty moving coil loud speaker.

The "Kukoo" loud speaker drive unit, manufactured by the Sheffield Magnet Co., is also exhibited. This promising component is of exceptionally heavy and solid construction, and employs two large cobalt steel magnets.

Tutills, Ltd., 7-9, *Swan Street, New Cross, Manchester.*

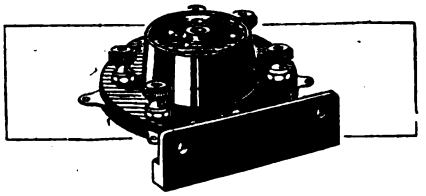
W.B. (7)

While the mounting of loud speakers in large moulded bakelite housings is a common practice, the new W.B. cone speaker, which is built in a bakelite case, is distinctive. It is probably the only bakelite mounted loud speaker of the "clock" design and its grained moulding gives a finish superior to that of polished wood, and is, of course, infinitely more durable. The bakelite back plate supports the adjustable differential reed movement. In spite of the generous use of bakelite the price of the complete speaker is 42s.



Interior of the W.B. balanced-armature loud speaker movement. The cover is of moulded bakelite.

For the home construction of an inexpensive cone loud speaker the balanced-armature movement is available for 12s. 6d. Double-ended extension shoes are attached to the poles of a cobalt steel magnet, and the armature is neutrally set through the axis of the bobbin.



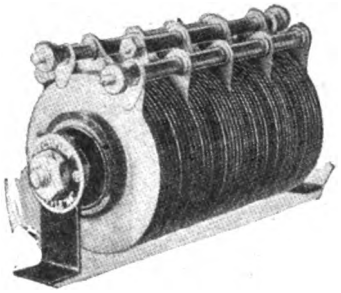
The new W.B. valve holder for side or baseboard mounting.

W.B. five-pin valve holders are well known to readers, and a modified pattern has now been introduced which, by means of a side plate, provides for horizontal or vertical mounting. The feature of W.B. valve holders is the expanding nickel-silver leg sockets. Like the circular pattern valve holder the price is 1s. 3d.

Whiteley, Boneham and Co., Ltd., Nottingham Road, Mansfield, Notts.

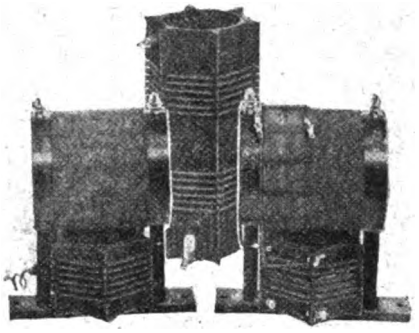
WESTINGHOUSE. (78)

Besides the H.T.1 and H.T.2 metal rectifiers, which have been reduced in price and the L.T. chargers and trickle chargers, there have been introduced for this season two new units for H.T.



Westinghouse A.4 rectifier, giving 2 amps. at 9 volts.

The H.T.3 is a half-wave instrument giving a voltage of 120 when the maximum load of 20 mA. is applied. Such a rectifier is useful for kit sets having a screened valve followed by leaky grid detector and triode output. The transformer feeding the H.T.3 should not give more than 140 volts on open circuit. The H.T.4 rectifier is designed to be used in a voltage doubling bridge circuit with two 4 mfd. condensers (if the capacity is less the output is considerably reduced). Although the transformer for use with this rectifier must not develop more than 135 volts, the D.C. output is about 180 volts 30 mA. There is thus a step-up irrespective of the transformer. The H.T.4 gives full-wave rectification and sells at 37s. 6d.



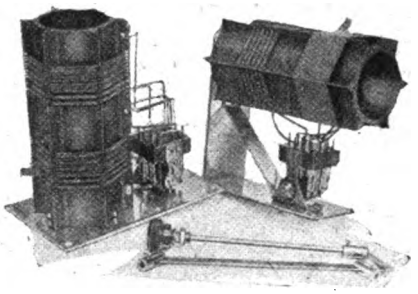
Coils for the 1930 Everyman Four (Wright & Weaire).

The A.4 unit, giving 2 amps. at 9 volts, is capable of charging large wireless batteries and is quite useful for car batteries.

Westinghouse Brake and Saxby Signal Co., Ltd., 82, *York Road, King's Cross, N.*1.

YAGERPHONE. (85)

Portable receivers and radio-gramophones are the chief products of this firm. The majority of these instruments are for all-mains operation, as much attention being paid to D.C. as A.C.



Coils with switches incorporated for "The Wireless World" Kit Set. (Wright & Weaire).

As an example of a moderately priced radio-gramophone for use with an outside aerial, mention should be made of the "Popular" model for battery operation, at £28 10s. There are three valves, arranged as two L.F. resistance stages following a regenerative leaky grid detector. This circuit allows of simple one-dial tuning. A cone speaker is built into the base of the cabinet and is hidden by an ornamental grille. There is a spring-driven Garrard gramophone motor with automatic stopping device. The cabinet work of the radio-gramophones exhibited is superb.

Yagerphone, Ltd., 28, *Charlotte Street, E.C.*2.

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RADIO in the FAR WEST

By OUR CANADIAN CORRESPONDENT.

"RADIO" and "The Air" are our names for the broadcast transmissions, and I should say they are as good as any; although it is said by some that, in the late presidential election in the U.S.A., Governor Smith, the unsuccessful candidate, lost a number of votes because he spoke of the "*Raddio*"!—so powerful is the influence of the ether.

Here in British Columbia, away up country, we are within reach of a really large number of broadcasting stations both Canadian and American; but our mountain ranges and our lakes run for the most part north and south, so it is the American stations that come in best. Our Canadian stations lie east and west of us. Calgary, in the province of Alberta, comes in fairly well; Vancouver only sometimes. If, therefore, we want an evening's straightforward radio, we switch on to one of the American stations; and that means Salt Lake City, Seattle, San Francisco or Los Angeles.

We are a very English community here in the Okanagan Valley, so that if you know anything at all of English people out of England you will know that we are very strong in our likes and dislikes, and when we have been listening, say, to a whole winter's programme from these American stations, it will be readily understood that "things are said". I think we are very grateful for the really marvellous range of programmes provided for us, and I have never once heard anything from any of the big American stations that could cause a moment's discomfort or uneasiness to the man who listens-in this side of the border. The programmes are arranged by the various mercantile corporations, and they are essentially a means of advertisement. The nature of the broadcast and the amount of advertising matter will therefore vary according to the character of the firm or the corporation.

Some of the best things are put on by the banks and by the powerful oil companies; and a very few words about the bank's business, or about the advantages of the oil, are all that accompany the symphony concerts which are the speciality of these institutions.

But they all have their turn, even down to So-an-So's pickles, a particular line of underclothing, or the This-and-That washing machine. Quite a small experience of radio will make you wary! You are listening, may be, to the "Venusberg" music from "Tannhäuser," beautifully rendered; the "Pilgrim's Chorus" is to follow; but before that begins the announcer must give you a cute little dissertation on the merits of X's soap, taking it for granted that there is no other kind of soap in the world, and that you certainly have never enjoyed a decent "wash" unless you have come across this particular brand. This is quite legitimate advertising, no doubt; but you listen to the "Pilgrim's Chorus," when it does come on, with a vague feeling that you have got a dirty neck.

The kind of English spoken by the American announcers is not of the quality which you hear from 2LO. If not exactly infinite in their variety, the voices are greatly diversified, and we all have our favourites. There is the voice with a smile, that is cheering to hear for a few nights, but which palls dreadfully after a time. There is the pained, hurt and aggrieved voice, as of a man having to read his own death sentence; and there is a voice for every stage between these extremes. Only very rarely do we hear the soft Southern drawl which in itself is perfect music.

This past season we have suffered from a superfluity of soprano singers. Some are good and worth listening to; others, many others, are neither good nor worth listening to; and it is sad to hear courtly and gallant old gentlemen switching off in disgust and muttering threats and slaughterings against "these squawking females." Indeed, these sopranos are so rife that many of us would prefer a saxophone, than which no more powerful indictment could be framed.

But our greatest grumble is that the announcer will not leave our poor intelligence alone. We are not allowed to listen to a Chopin's Nocturne without being told who Chopin was (presumably it *is* he who is meant by "Show-pang"), and we must be informed what a nocturne is. And then, perhaps, we are told that we are to hear "Nocturne," by Chopin—as though he wrote one only!

To have our intelligence improved in this way is bad enough; it is worse when our emotions are got hold of and straightened out. For instance, they are going to play a Minuet of Beethoven's, but before we get to it we are told what our reactions should be to "this piece," and so stereotyped is this kind of advice that in nine cases out of ten a man may safely wager that he will hear, at least once, phrases such as "delicate cadences," "swinging lilt," "felicitous movement," "swaying rhythm," "charm," "romance," "quaint." These grumblings, after all, amount to very little in comparison with the abundance of the musical feast provided by the many stations we tap here in the North-West.

The most impressive broadcast I ever heard was late on the last night of the Old Year, when New Year messages were being sent out from the Edmonton Station to listeners-in away up among the isolated settlers and officials in the Yukon and the North-West Territories, close by the Arctic Circle. Many a heart-ache must have been lifted that night when those lonely people heard over the radio the names of their home-folk who remembered them.

The Spirits of the Air fulfil their kindly mission nowadays, not only in fairy-tales but in real life.

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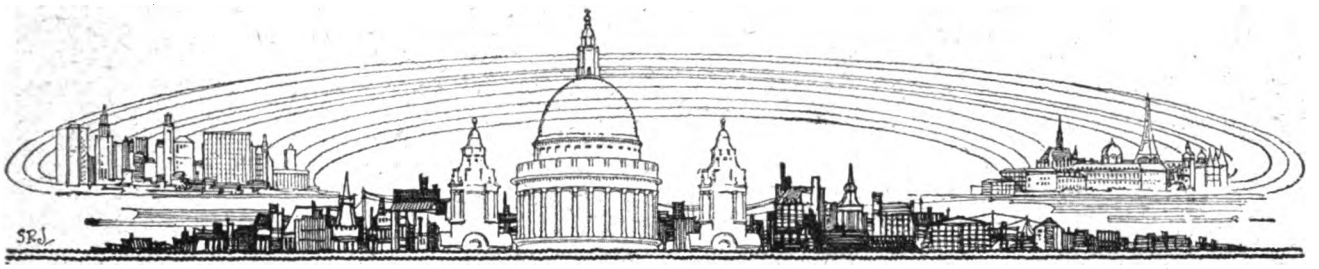

CURRENT TOPICS

Events of the Week in Brief Review.

HIGH POWER BROADCASTING IN IRELAND.

Following the B.B.C. example, the Irish Free State Postal and Finance Departments are considering the erection of a high power broadcasting station in Athlone. It is not yet clear whether the Athlone station will supersede those at Dublin and Cork, but it is certain that it will be designed to include practically the whole of the Irish Free State in its service area.

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MOTOR CAR WIRELESS.

A time when every car will carry a receiver, if not a transmitter, is suggested by the news that the Radio Corporation of America and General Motors have organised a new concern, known as General Motors Radio Corporation, for the manufacture of motor car wireless sets.

Wireless may soon be an indispensable "gadget."

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WHY CRIMINALS HATE WIRELESS.

The increased use of wireless by Scotland Yard has been carefully watched by the French police. In the coming Budget funds will be specially allocated for the erection of a wireless station in Paris to link up with the frontiers, ports and provincial police stations.

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THE STORY OF THE VALVE.

A talk on "The History of the Thermionic Valve" will be given from the Dublin broadcasting station at 10.30 p.m. on October 30th by Mr. H. A. Donisthorpe, of the General Electric Co., Ltd.

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RADIO BEACON'S SUCCESS.

The new Air Ministry rotating wireless beacon at Orford Ness, Suffolk, has proved so successful that, as from Sunday last, October 20th, the beacon works continuously throughout the 24 hours instead of from 6 a.m. to midnight. The revised timing will continue for two months.

The Trinity House observers state that out of 21 observations only five showed an error of 1 degree. In tests as to the accuracy of its time-keeping, the National Physical Laboratory found that the accuracy was well beyond the limit of accuracy of the ordinary chronometer or stop-watch.

Practically correct results have been obtained on a vessel off Beachy Head, 100 miles distant.

BRITISH GEAR FOR SPANISH-ARGENTINE SERVICE.

The new Spanish-Argentine radio telephone service recently opened from Seville by General Primo de Rivera is the only service of its kind in the world, with the exception of that between Great Britain and America, in which subscribers are connected at each end by means of the ordinary telephone service. Complete secrecy is obtained by transmitting in a distorted form unintelligible to ordinary receiving stations. The transmitters and receivers for this new radio link were manufactured by Standard Telephones & Cables, Ltd., in their factories at Woolwich and Hendon.

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MORE LISTENERS IN GERMANY.

Registered listeners in Germany now number 2,843,569, an increase of 16,941 in three months.

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SAD CASE.

The pirates' repertoire of excuses has been added to by a Doncaster delinquent who pleaded last week that he thought the second-hand receiver he had purchased was already licensed, like a car.

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RADIO IN RANGOON.

To popularise wireless in rural India the Burma Legislative Council has voted 3,000 rupees for the installation of receiving sets in twelve villages within 100 miles of Rangoon. The Rangoon broadcasting station is operated by the Burma Radio Syndicate on a wavelength of 398 metres.

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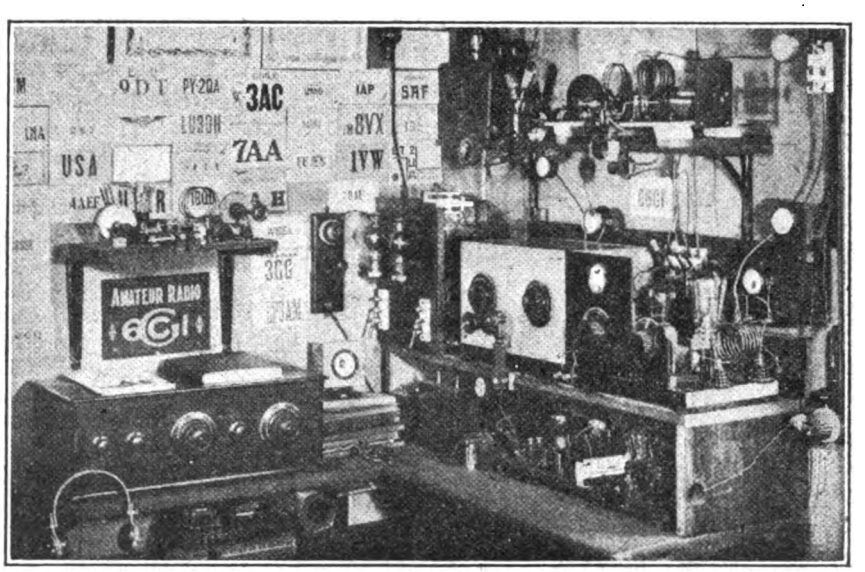
LECTURES FOR RADIO-GRAMOPHONE DEALERS.

Under the auspices of the Gramophone Co., Ltd., a special course of sixteen lectures in radio-gramophone re-production is being given at the London Polytechnic, Regent Street, by Mr. S. T. Short, A.M.I.E.E., for the benefit of dealers, salesmen, service staff and others engaged in the radio-gramophone industry. Similar courses are to be given in various provincial centres. Particulars of the courses and of a special correspondence course for those unable to attend the lectures, are obtainable from The Gramophone Co., Ltd., 363, Oxford Street, London, W.1.



A MODERN AMATEUR STATION. The transmitting and receiving apparatus of G 6CI, owned by Mr. B. W. Warren, of Coventry. As the QSL cards indicate, G 6CI has practically a world-wide "service area."

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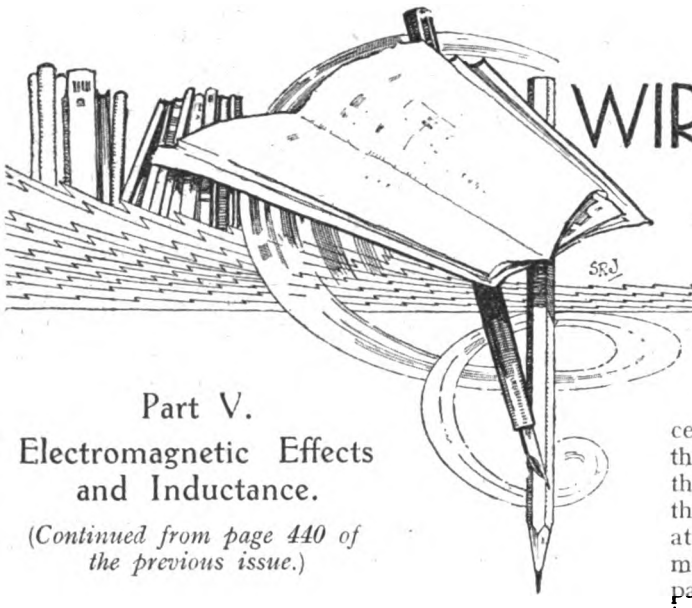

WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

Part V.
Electromagnetic Effects and Inductance.

(*Continued from page 440 of the previous issue.*)

BEFORE we can proceed further with A.C. theory it will be necessary to know something about that type of circuit in which considerable magnetic effects are produced when a current of electricity flows through it. It will be seen later what a very important part inductance plays in A.C. circuits.

Whenever a current of electricity flows through a circuit a magnetic field is set up in the vicinity of the conductors. With the aid of a miniature compass needle, lines of force can be detected and the directions in which they act determined. The intensity of the field depends on the nature of the circuit and the strength of the current flowing through it. For instance, if a long insulated wire is wound into the form of a coil or solenoid, a relatively powerful magnetic field is produced when a current is passed through it. The lines of action of the forces pass through the coil parallel to its axis at the centre, and spread out brush-wise at the ends.

If such a coil could be arranged so that its axis lies on a plane surface, as shown in Fig. 1, the lines along which the magnetic forces act could be traced out with the aid of the little compass needle. If any one line is followed completely round, it is found to be a closed loop, so that we have in a magnetic field a large number of closed loops of magnetic force linked with the turns of the coil.

The total magnetic influence passing through the centre of the coil parallel to its axis is referred to as the *magnetic flux*, and the amount of flux which passes through one square centimetre of area at right angles to the lines of force represents the field strength or intensity at that point. It is expressed in lines per square centimetre or *gauss*. If a current of I amperes could be passed round a single circular wire loop one centimetre in radius, the field strength at the centre of the loop would be $0.2\pi I$ lines per square centimetre or *gauss*.

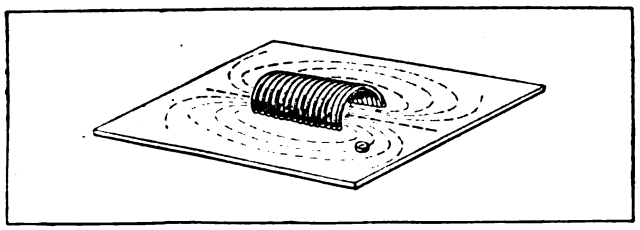

Fig. 1.—Showing how the lines of magnetic force produced by a coil can be traced by means of a miniature magnetic compass.

Electromagnetic Induction.

If the current flowing through the coil is varied, the magnetic flux linked with the coil varies in direct proportion, and this changing of the flux has a peculiar effect on the circuit. It actually causes an electromotive force to be *induced* in the turns of the coil, this being the property known as *self-inductance*.

The explanation of self-inductance will be made simpler if we first consider the action of a permanent magnet on a coil of wire. In Fig. 2 is shown a permanent magnet of the horseshoe pattern with lines of magnetic force passing between the poles from N to S. Close to the magnet is a coil so placed that one pole of the magnet can be lowered into it, and across the ends of the coil is connected a sensitive galvanometer or millivoltmeter. When the magnet is lowered, the lines of force passing between the poles are "cut" by the turns of the coil, and just as this is happening a reading is obtained on the millivoltmeter, showing that an E.M.F. is being induced in the coil. This is Faraday's original experiment, and explains the principle of electromagnetic induction.

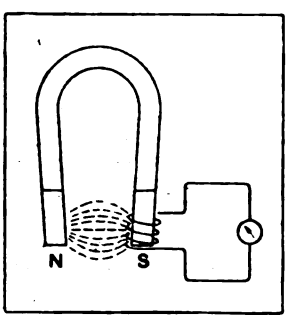

Fig. 2.—Faraday's experiment for demonstrating the principle of electromagnetic induction.

The important feature is that the E.M.F. is induced in the coil only so long as the magnet is moving relatively to the coil; as soon as the magnet comes to rest the E.M.F. disappears, no matter what the relative positions of the magnet and coil are. The value of the induced E.M.F. is exactly proportional to the rate at which the lines of force are being cut, i.e., to the

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Wireless Theory Simplified.—

number of lines being cut per second, and therefore *to the rate at which the flux linked with the coil is changing.*

Reverting to the case in which the magnetic flux linked with a coil is produced by a current in the coil itself, it will be clear that an E.M.F. will be induced in the coil whenever the current is changing, because the magnetic flux is proportional to the current. In any circuit where the changing of the current causes an E.M.F. to be induced into the circuit itself, self-inductance is said to be present.

From the foregoing it follows that inductance will be present in any circuit where a magnetic field is produced by a current passed through the circuit.

Unit of Self-Inductance.

The practical unit of self-inductance is the *henry*, and a circuit is said to have a self-inductance of one henry if one volt is induced in it when the current is changing at the rate of one ampere per second. The self-inductance expressed in henrys is called the *coefficient of self-induction* of the circuit, and is usually denoted by L.

Suppose that in a circuit where the inductance is L henrys the current is changing at a steady rate and increases from I_1 to I_2 amperes in t seconds. Then the rate of change of current is $\frac{I_2-I_1}{t}$ amperes per second, and the self-induced E.M.F. will be $e = L \times \frac{I_2-I_1}{t}$ volts.

Electrical Inertia.

Before we can make full use of this expression it is necessary to know in what direction the induced E.M.F. acts. Lenz's law states that the induced E.M.F. always acts in such a direction as to oppose the changing of the current. This means that if the current is increasing, the induced E.M.F. will be opposing the applied E.M.F. actually producing the current, and when the current is falling in value the self-induced E.M.F. acts in such a direction that it tends to maintain the current. The self-induced E.M.F. is very often referred to as a *back E.M.F.* or counter electromotive force when it acts in opposition to the applied E.M.F.

A similar law exists in ordinary mechanics—a heavy body resists the taking up of motion when a force is applied to it on account of its *inertia*; there is a back pressure proportional to the mass of the body and the rate at which its velocity is changed. Once the body is set in motion, it tends to continue moving even after the original driving force has been removed. A railway wagon on a level track could be taken as an example.

Owing to the similarity of the laws of an inductive circuit and those of inertia, self-inductance is very often referred to as "electrical inertia." Since the induced E.M.F. is proportional to the rate of change of current and acts in opposition, it follows that in a circuit possessing self-inductance the current can never be changed instantaneously. If the E.M.F. applied to the ends of the circuit is suddenly changed, the current will *gradually* acquire its new value just as, if the throttle of a motor car running at slow speed is suddenly opened wide, the car does not attain its full speed instantaneously, but gradually accelerates.

Energy Stored in a Magnetic Field.

If an electromotive force is suddenly applied to the ends of an inductive circuit, power is expended not only in heating the circuit through the medium of its resistance but also in overcoming the back E.M.F. during the time that the current is building up. When the current has reached its final steady value, the back E.M.F. disappears, and the whole of the in-going energy is being converted into heat. It is clear then that just as the current is building up, a certain amount of energy is put into the magnetic field. When the current is reduced to zero again, the induced E.M.F. of self-induction acts in the same direction as the falling current, and hence the stored energy is given back again to the circuit. In the case of a very powerful field such as that of a large dynamo, the stored energy is so great that it is positively dangerous to switch off the magnetising current suddenly. Even in the case of the pot magnet of a moving-coil loud speaker precautions are usually taken to dissipate the stored energy gradually when switching off.

Calculation of Stored Energy.

Suppose that we have a coil whose inductance is L henrys and that a current is caused to build up in it from zero to I amperes in t seconds. The average rate of growth of the current will be $\frac{I}{t}$ amperes per second, and, since the induced E.M.F. is equal to the product of the inductance and the rate of change of current, the average back E.M.F. during this time will be $e = L \times \frac{I}{t}$ volts. Now, the power consumed in building up the magnetic field is given by the product of back E.M.F. and current at any instant. But the current is varying from zero up to I amperes, and therefore its *average* value during the time of growth is $\frac{1}{2}I$ amperes (see Fig. 3). Thus the average power expended on the field whilst it is being built up is

$$e \times \tfrac{1}{2}I = L\frac{I}{t} \times \tfrac{1}{2}I$$
$$= \tfrac{1}{2}\frac{LI^2}{t} \text{ watts.}$$

The time during which this power acts is t seconds, and so the energy put into the field is

$$W = \tfrac{1}{2}\frac{LI^2}{t} \times t = \tfrac{1}{2}LI^2 \text{ watt-seconds or } \textit{joules}$$

(the energy represented by a power of one watt expended for one second is called one *joule*).

The energy stored in the field at any instant is thus seen to be proportional to the inductance of the circuit and to the *square* of the current at that instant. It is assumed that the energy thus stored takes the form of a sort of strain in the ether in which the magnetic field is situated.

Mutual Induction.

Sometimes two circuits are so arranged that when a current in one of them is varied it causes an electro-

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Wireless Theory Simplified.—

motive force to be generated in the other. Under these conditions *mutual inductance* is said to exist between the circuits. It should be fairly obvious then that if a current in one circuit causes lines of magnetic force to be linked with a second circuit, mutual inductance will be present, because any variation of current in the one will result in an induced E.M.F. in the other.

As an example, we may consider two coils L_1 and L_2 arranged as shown in Fig. 4. When a current is passed through L_1 from a battery B it will produce a magnetic field, part of which links itself with the turns of L_2. If the current is varied by changing the value of the regulating resistance R, the flux linked with L_2 will be altered, and an E.M.F. is induced in it during the process.

The mutual inductance between the coils is said to be one henry if one volt is induced in one of them when the current in the other is changing at the rate of one ampere per second. The mutual inductance in henrys is usually denoted by M, and is sometimes called the coefficient of mutual induction. The coil L_1 in which the current flows is called the primary (coil), and L_2 is called the secondary. The mutual inductance between the two coils is the same, no matter which is used as the primary; its value depends only on the dimensions of each coil and their relative positions.

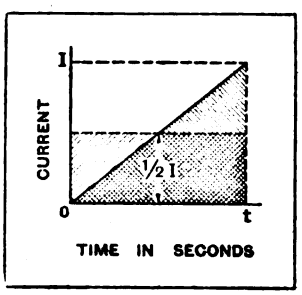

Fig. 3.—When a current is increased from zero to I amperes at a uniform rate the average value is ½I amps.

When the mutual inductance is M henrys, the E.M.F. induced in the secondary coil is given by

$e_2 = M \times$ (rate of change of primary current).

If an alternating current is passed through the primary coil, an alternating magnetic flux will act upon the secondary coil, and so induce in it an alternating voltage of the same frequency as the primary current. When two coils are used in this way they are said to be magnetically coupled together, and the combination is known as a transformer, a subject to be dealt with separately at a later date.

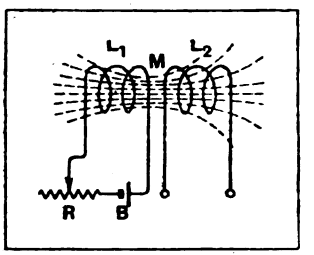

Fig. 4.—Mutual inductance exists between two coils if a current in one affects the other magnetically.

Degree of Coupling.

The two coils are said to be tightly coupled when they are brought close together so as to obtain a relatively high mutual inductance, and *vice versa*. The degree of coupling is expressed as the ratio of the mutual inductance to the square root of the product of the separate self-inductances, this ratio being known as the coefficient of coupling,

i.e., $$\text{coefficient of coupling} = \frac{M}{\sqrt{L_1 L_2}}$$

In theory the coupling coefficient can never be greater than unity, and in practice never reaches this value. The coupling would be unity if the whole of the magnetic flux produced by a current in one coil linked itself with the whole of the turns on the other. In low-frequency transformers the coupling is made as great as possible by winding the two coils on a common iron core so that the total flux is constrained as far as possible to be fully linked up with both windings. That fraction of the total flux which fails to link with both coils is termed leakage flux.

(To be continued.)

CLUB NEWS.

Peckham Radio Society.

Many South London amateurs have derived benefit from the Peckham Radio Society, which has now opened the winter session with meetings on Thursday evenings at 7.30 p.m.

Hon. Secretary, Mr. A. E. Pettet, 192, Hollydale Road, S.E.15.

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Informality in Wireless Meetings.

A request that the informal nature of its meetings should be maintained was made by members of the South Croydon and District Radio Society at the recent Annual General Meeting. It was felt that the ordinary owner of a wireless set derived most benefit when he could discuss his radio troubles and experiments with a minimum amount of formality. A feature of the new session is the arrival of a large contingent of new members. More vacancies still exist, however, and the Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, South Croydon, will be glad to receive applications.

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A Topical Lecture.

"Mains Apparatus—Its Design and Operation" was the title of a lecture given by Mr. Garside, of Messrs. Ferranti, Ltd., at a recent meeting of the Kensington Radio Society.

The Society's meetings are held at 136, Holland Park Avenue, W.11. Hon. Secretary, Mr. G. T. Hoyes, 71a, Elsham Road, Kensington, W.14.

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Bec Radio Society.

The programme of the Bec (Streatham-Tooting) Radio Society, which has commenced the new session, includes weekly lectures and demonstrations, visits to places of wireless interest, and tests with members' sets and apparatus. Meetings are held every Tuesday, from 7.30 to 9.30 p.m., at the Literary Evening Institute, Bec School, Beechcroft Road, S.W.17. Hon. Secretary, Mr. A. L. Odell, 171, Tranmere Road, S.W.18.

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Meetings Twice Weekly.

The Alma Radio Society, which recently opened a new session, holds meetings twice weekly, on Tuesdays and Thursdays, from 7.30 to 9.30 p.m., at the Bermondsey Men's Evening Institute, Southwark Park Road, S.E.15, under the direction of Mr. S. F. Harris (G5SH). The club possesses a good collection of tools and wireless apparatus. An attractive syllabus has been prepared, and full particulars can be obtained from the Hon. Secretary, Mr. A. J. Hopkins, 41, Trafalgar Road, S.E.15.

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Wireless in the Isle of Wight.

Readers in the Isle of Wight will be interested to learn that the Ryde Radio Society has resumed meetings, its headquarters being Mount House Hall, George Street, Rye. An interesting programme has been prepared and includes lectures by representatives of leading radio manufacturers. There will also be a "query" night and a "surprise" night.

The meetings take place every Tuesday at 8 p.m. Applications from prospective members will be gladly received by the Hon. Secretary, Mr. Ivor Goddard, "Brinkcliffe," Sandown.

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For Muswell Hill Readers.

One of the most active of the London Societies last year was the Muswell Hill and District Radio Society, which has resumed meetings at Tollington School, Tetherdown, Muswell Hill, N.10, on Wednesday evenings at 8 o'clock. Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road.

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A Refractory Receiver.

A unique set, the circuit diagram of which puzzled even the veterans present, was demonstrated by Mr. Newington at the last meeting of the South Croydon and District Radio Society. Piquancy was added by the fact that the set at first refused to function, but after an animated discussion it was discovered that by changing the position of two variable condensers the trouble was overcome!

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

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An October Field Day.

Six members of Slade Radio (Birmingham) succeeded in tracking down a hidden transmitter on the occasion of the Society's field day on October 13th. Thirty-five members and friends took part in the hunt. After the test the company enjoyed an alfresco tea, which was followed by the distribution of prizes. Full particulars of the Society's activities will be gladly supplied by the Hon. Secretary "Enville," Warren Road, Erdington.

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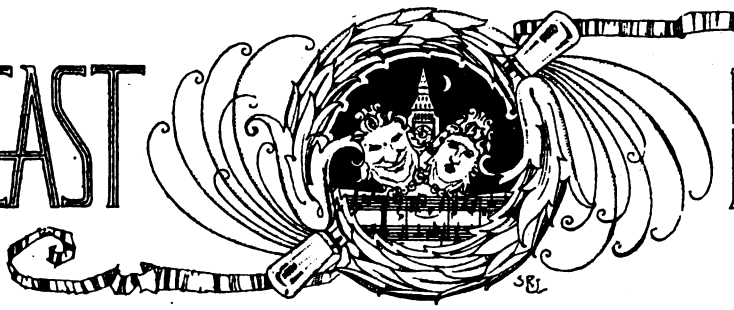
BROADCAST BREVITIES



By Our Special Correspondent.

What of the Twin Transmitter?—Continental Relays.—B.B.C. Finance.

The Sleeping Partner.

Despite rumours to the contrary, I understand that it is extremely unlikely that London Regional No. 2 will have anything to tell the world until mid-December. Why there should be such a delay is rather difficult to fathom, for the second station is already in working order, and the B.B.C. has the Postmaster-General's permission to go ahead with alternative transmissions.

One would have thought that even the cautious conservatism of the B.B.C. engineers would have been outweighed by their anxiety to discover as soon as possible whether twin-wave working from the same site can be a practical success. So far, its practicability is only theoretical.

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Weekly Relays from the Continent.

Those long-distance listeners who are threatened with a curtailment of their activities owing to the enormous power of the new regional stations will wonder whether there is any special significance behind the fact that the B.B.C. is urgently negotiating for a series of regular relays from Continental stations.

I hear that present plans provide for a weekly "Continental" evening during the coming winter. The new La Panne-Thanet cable will form the connecting link with the Continent. It is hoped that programmes will be available from Belgium, Holland, Germany and France.

oooo

The Money Question.

Tales have been going the rounds that the B.B.C. is desperately "hard up." It would be doubtful policy for Savoy Hill to contradict such statements, but I can definitely say that it is not money troubles that loom largest in the official mind at the present moment. At the end of next year, however, some heavy calls will be made on the exchequer, including the cost of the Moorside Edge Regional Station, and it would not be surprising if the B.B.C. were then to demand an enquiry into the existing system of allocating licence moneys whereby both the Post Office and the Treasury reap more than an adequate profit.

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Work Begins at Moorside Edge.

The contract for the erection of the station buildings at Moorside Edge has been secured by the Anglo-Scottish Construction Co., Ltd., of Victoria Street, Westminster. Work on the site will begin almost immediately.

It is hoped that the station will be ready to start exactly a year hence.

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The B.B.C.'s Chief Spokesman.

Mr. Gladstone Murray, who poured oil on the troubled waters of political broadcasting at the opening of the Manchester Show, is becoming recognised as one of the leading spokesmen of the B.B.C. Since 1927, when he was appointed Assistant Controller of Broadcasting at the age of 34, Mr. Gladstone Murray has been the close assistant of the Director-General, an experience which has given him a probably unrivalled insight into the countless problems affecting the control of a monopolistic broadcasting service.

I venture to suggest that before long we shall hear a good deal more of Mr. Gladstone Murray.

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Sir Oliver Lodge's Point of View.

Sir Oliver Lodge will give listeners his views on passing events in a broadcast from a London studio on November 1st. This is the sixth half-hourly talk in the "Points of View" series, which has aroused so much discussion, favourable and unfavourable, amongst the public.

oooo

Dilemma in Belfast.

Belfast listeners are still wondering what actually happened at 2BE on a recent Sunday. I can now tell the story, which must surely rank as a broadcasting epic. Owing to heavy rains the land lines connecting the studio with the transmitter were put out of action shortly before the Sunday afternoon programme was due to begin. As all S.B. lines terminate at the studio it was impossible to broadcast the London programme as announced. But all Belfast was waiting for a programme.

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Rehearsing in a Power Station.

Nothing daunted, the engineers transported a gramophone to the transmitter, together with two large amplifiers and 500 volts of high tension, and in an amazingly short time an impromptu programme was being radiated. While this was going on a "studio" was hastily rigged up in a small office in the adjoining power station, and at 8 o'clock it was possible to transmit a religious service with gramophone records of hymns, and later a programme by the Whiteway String Quartet. I am told that it was one of the sights of the century to see this hurriedly assembled combination rehearsing in the power station, surrounded by huge turbo-generators, switchboards and rotary converters! Normal working was not resumed until Tuesday.

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Copyright Music at Cenotaph Service.

The B.B.C. issues a hint to those persons who may be arranging for the re-diffusion of the Cenotaph broadcast on Armistice Day ("re-diffusion" is a word commonly used at Savoy Hill in reference to loud speaker reproduction in public places). Whilst it is felt that no action would be taken for infringement of copyright, the B.B.C. disclaims all responsibility in the matter. But we may assume that no copyright holder would assert his claims on such a special occasion, and organisers of public gatherings on November 11th would be well advised to proceed with loud speaker arrangements without worrying themselves with questions of copyright. Far more important is the question of good reproduction.

FUTURE FEATURES.

London and Daventry.

OCTOBER 30TH.—"Aida" (Verdi).
OCTOBER 31ST.—Hallé Concert from Manchester.
NOVEMBER 2ND.—A Burlesque Talkie.

Daventry Experimental (5GB).

OCTOBER 27TH.—"The Golden Legend," an oratorio by Sullivan.
OCTOBER 29TH.—"Michael," a play by Miles Malleson adapted from "What Men Live By" (Tolstoy).

Cardiff.

NOVEMBER 2ND.—Popular Concert relayed from National Museum of Wales.

Manchester.

OCTOBER 28TH.—"Establishing Relations," a comedy by W. W. Jacobs.
OCTOBER 31ST.—Hallé Concert relayed from Free Trade Hall.

Glasgow.

OCTOBER 29TH.—"The Jolly Beggar," a Cantata, words by Robert Burns, music by W. A. Henderson.

Aberdeen.

OCTOBER 30TH.—Scottish Instrumental Concert and Songs.

Belfast.

OCTOBER 28TH.—"At the Sign of the Tabard," a Song and Story Programme.
NOVEMBER 2ND.—"Sax Appeal," a saxophone musical programme.

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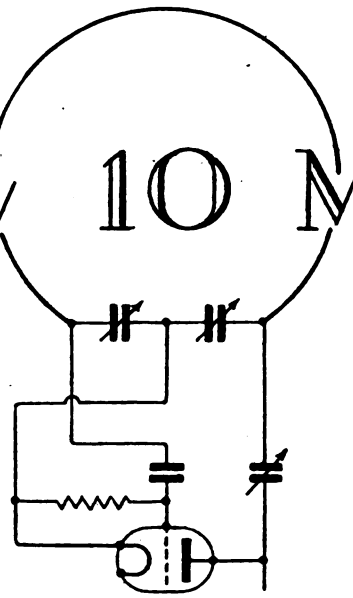
Below 10 Metres



Some Experimental Receiving Apparatus for Ultra-short Waves.

By R. L. SMITH-ROSE, D.Sc., A.M.I.E.E., and J. S. McPetrie, B.Sc.

APPARATUS characteristic of the latest practice in the transmission of ultra-short waves has already been described[1]; it remains to deal in this article with the methods adopted for their reception.

There is nothing radically new in the design of receiving apparatus for use on very short wavelengths, the main difference from receivers suitable for longer wavelengths being a general reduction in inductance and capacities. Stray capacities become very important at frequencies of the order of 50 million cycles per second, and very careful layout of the components is necessary. Before describing in detail any specific receiver it will be useful to review the various types of receiver which have been used with success on longer wavelengths. The simplest type of receiver which has found widespread use on wavelengths below 100 metres is that employing a single-valve detector with variable capacity retroaction. For the reception of modulated continuous waves this retroaction can be set critically at a point just below that at which the valve oscillates, while at a point just above this the receiver is in a very sensitive condition for the reception of continuous waves. Any valve circuit, therefore, which will oscillate freely at the working frequency and can be controlled by suitable adjustment of the retroaction may be made to serve for reception purposes. Where additional sensitivity is required the possibilities of direct radio-frequency amplification immediately arise. Considerable experience with various types of radio-frequency amplifiers has shown that it is extremely difficult to obtain any appreciable amplification on wavelengths shorter than about 15 metres.

In receivers using one or more stages of amplification at these high frequencies, it is usually found that any amplification obtained is got at the expense of the retroaction setting of the detector, and that if the high-frequency stages are removed this retroaction can be increased so that there is little overall loss in sensitivity. To avoid this decrease in available retroaction when using high-frequency stages, certain investigators have developed the super-regenerative type of circuit. In this arrangement it is possible to use more retroaction as the valve is prevented from dropping into oscillation by the quenching action of a supersonic oscillation at a lower frequency than that of the signals to be received.

Little work has been done on the development of the supersonic heterodyne receiver for wavelengths less than 10 metres, although this would appear to offer the greatest possibilities. It is a comparatively simple matter to obtain considerable voltage amplification at an intermediate frequency of the order of 100 kilocycles per second (3,000 metres). In order to use such an intermediate frequency amplifier in a short-wave receiver, it is necessary merely to precede it by a frequency changing unit, which generates oscillations of such a frequency as to heterodyne that of the incoming signals. By the substitution of different frequency-changing units it would appear possible to extend the range of such a receiver down to the shortest

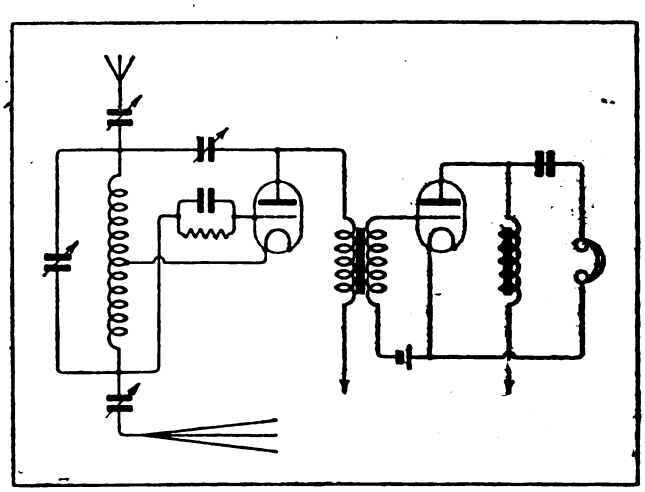


Fig. 1.—Circuit diagram of a two-valve short-wave receiver using a centre-tapped input coil capacity-coupled to aerial and counterpoise.

[1] *The Wireless World*, Oct. 9th, 1929, p. 398.

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Below 10 Metres.—
wavelengths at which receiving valves may be made to oscillate.

A Receiver for Use with Aerial and Earth Connections.

The two receivers described below were developed by the authors to meet the requirements of the simplest type of receiver which could be used in a study of the propagation of very short waves. For these receivers the single-valve retroactive detector has been employed, followed by one stage of transformer-coupled low-frequency amplification.

The circuit diagram of one of these receivers is given in Fig. 1. In this the tuning inductance is centre-tapped, as at this point there is no alternating potential, and by connecting the centre of the coil through a suitable battery to the negative end of the filament any required bias may be applied to the grid of the detector valve without interfering with any alternating electromotive forces in the tuned circuit. An open aerial can be coupled to one end of the coil by a variable condenser having a capacity of about 50 micro-micro-farads. If a definite earth connection is employed, this should be made to the centre of the coil for the same reasons as given above for the centre-tapping. If, on the other hand, an insulated counterpoise system is preferred, this may be coupled to the other end of the coil from the aerial through a condenser of similar dimensions to that used for the aerial.

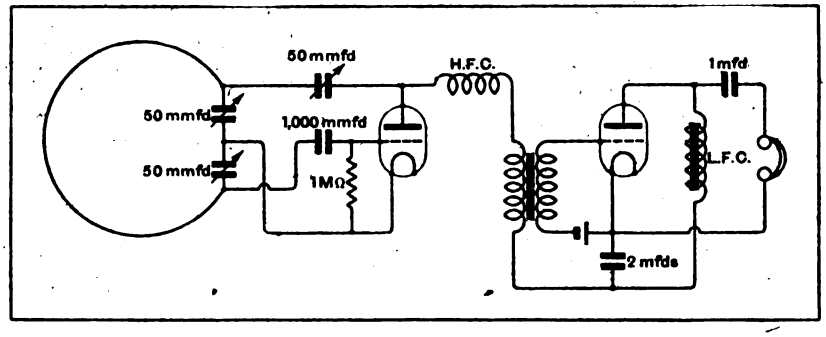

Fig. 2.—Circuit diagram of a two-valve short-wave loop receiver for field-strength measurements and direction finding. The wavelength range is from 4 to 10 metres.

It is important to observe that in this circuit both ends of the inductance coil are at high alternating potentials, and the aerial and counterpoise connected to them should be so adjusted that they have potential variations impressed by the incoming signals at the ends coupled to the tuning inductance. It is important, therefore, that the length of either should not be an odd multiple of a quarter of the wavelength, since this would provide a potential node at the receiver. The condition for optimum reception with this type of circuit involves the adjustment of the length of the aerial and all the controls of aerial coupling, retroaction, and, of course, tuning. The correct adjustment of aerial coupling is particularly important since, if it is too great the radiation resistance of the aerial, which at these short wavelengths is high (of the order of 50-80 ohms), will prevent the detector from oscillating, while if it is too small a loss in sensitivity will result.

Variable Condensers for Short Waves.

For wavelengths between 5 and 10 metres a condenser having a maximum capacity of 50 micro-micro-farads is suitable for the main tuning condenser. This condenser should have reasonably small linear dimensions, as at this short wavelength the inductance of the plates themselves becomes important. Another advantage of such a small condenser is that there is usually less stray field to create losses in the insulators supporting the plates. A condenser of similar capacity and design is suitable for retroaction purposes and for coupling the aerial and counterpoise to the coil. The grid condenser should be fairly large as it was found that it tended to stabilise the oscillations: a fixed condenser having a capacity of about 1,000 micro-micro-farads will be found suitable. The grid leak should have low self capacity, and have a resistance of between 0.5 and 2 megohms according to the valve used. The time an electron takes to travel from the filament to the anode should always be small compared with the period of the wave which the valve is receiving: for this reason it may be found necessary to use short-path valves for wavelengths below about 5 metres. Small diameter wire has an appreciable inductance, and so to avoid unnecessary reactance in the leads at very high frequencies all wiring should be made in reasonably thick wire, say, No. 16 S.W.G. Such wire has the additional advantage of rigidity, an essential feature at these high frequencies. Suitable coils may be made from ⅛in. or ¼in. aluminium or brass tubing. With ¼in. tubing and components complying with the above conditions it was found that with a centre-tapped 4-turn coil with internal diameter of 1in. and 2in. long, the wavelength range extended from 4.7 to 7 metres, while with another 4-turn coil of equal axial-length but having a diameter of 1⅛in., the available range was from 5 to 12 metres. It is advisable to mount such coils on ebonite or American whitewood to prevent change in shape which, of course, alters the inductance of the coils.

Frame Aerial Reception.

For measurement purposes, it is essential to cut down the number of variables involved in the transmission and reception of the waves and, for this purpose, a small loop receiver was designed in order to do away with the necessity for an aerial. This loop is mounted directly on a screened box measuring 20in. × 10in. × 8in., which contains all the receiving apparatus. In this way everything except the pick-up loop and the telephone leads is screened, a distinct advantage when measurements are required. For wavelengths below 10 metres the product of area and turns of the receiving loop is comparatively small, and it was decided to construct the loop of single turns of brass tubing. With single-turn coil receivers a centre tapping on the tuning

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Below 10 Metres.—

coil is objectionable, and, to avoid this, the circuit arrangement shown in Fig. 2 is adopted for the detector.

The tuning adjustment is effected by two variable condensers of maximum capacity, 50 micro-microfarads, each mounted in series on a common spindle, the tapping to the filament being taken from their common connection. Latterly this connection has been omitted, the centre of the double condenser being allowed to take up its own "earth" point. By omitting this connection the capacity across the tuning loop is effectively decreased, and the range of the receiver is thus extended in the direction of shorter wavelengths. A photograph of a complete receiver built on the above lines is shown in Fig. 3. The front lid of the box has been removed to show the internal arrangement of the components. The diagram of connections and the dimensions of the principal components are given in Fig. 2. The details in design emphasised in the description of the previous receiver obviously apply in this case also. In order to make the whole receiver as symmetrical as possible about the loop, and also to shorten the lengths of wires in the detector stage, the apparatus is arranged within the box in three tiers, as indicated in the photograph. The top tier contains the tuning condensers, the reaction condenser, the grid condenser and leak, along with the first valve and a radio frequency choke. The loop is held rigidly to an insulating strip on the top of the box by two terminals to the underside of which is attached the tuning condenser. This tuning condenser, and also the reaction condenser, are mounted on a panel which, when in position, lies about 1½in. from the back of the box. This mounting is necessary in order to keep stray capacities at a minimum. Extension handles pass from the condensers through the box and are connected to dials at the back.

H.F. Chokes.

It is advisable to be able to change the choke and grid leak, so these were arranged to fit into sockets provided on the top platform. Little systematic investigation has been made into the working of choke coils at very high frequencies, but a design which the authors have found fairly satisfactory consists of a solenoidal coil of No. 47 S.W.G. insulated copper wire wound uniformly on a 3in. × ½in. ebonite former. A range of chokes may be made by varying the number of turns from about 50 to 200. The ends of the wires are soldered to two valve pins screwed into the ends of the ebonite, and, by keeping the distance between these pins the same for all chokes, it is a simple matter to make them easily interchangeable. It is desirable in fixing the positions of the pins to remember that the farther they are apart the less will be the self-capacity of the choke.

A single audio-frequency amplifying stage is mounted on the middle platform of the box, while the necessary filament and high-tension batteries are placed at the bottom of the box. The screening box is used as the lead to the negative end of each filament, as this decreases the number of wires necessary in each compartment. The output terminals for the telephones are placed as a shunt across an audio-frequency choke in the anode circuit of the second valve. By this means the telephones and, therefore, the observer are maintained at the potential of the screening box (see Fig. 2). This design diminishes certain difficulties due to capacity changes while tuning, and also prevents the high-tension battery being short-circuited when the telephone terminals come accidentally into contact with the box. In order that the screening may be efficient, the box and lid are bolted together when the receiver is in use.

Wavelength Range of Loop Receiver.

Using single-turn loops constructed of ⅛in. diameter copper tubing, the following wavelength ranges are covered with a tuning condenser, of which the minimum and maximum capacities are 2 and 25 micro-microfarads

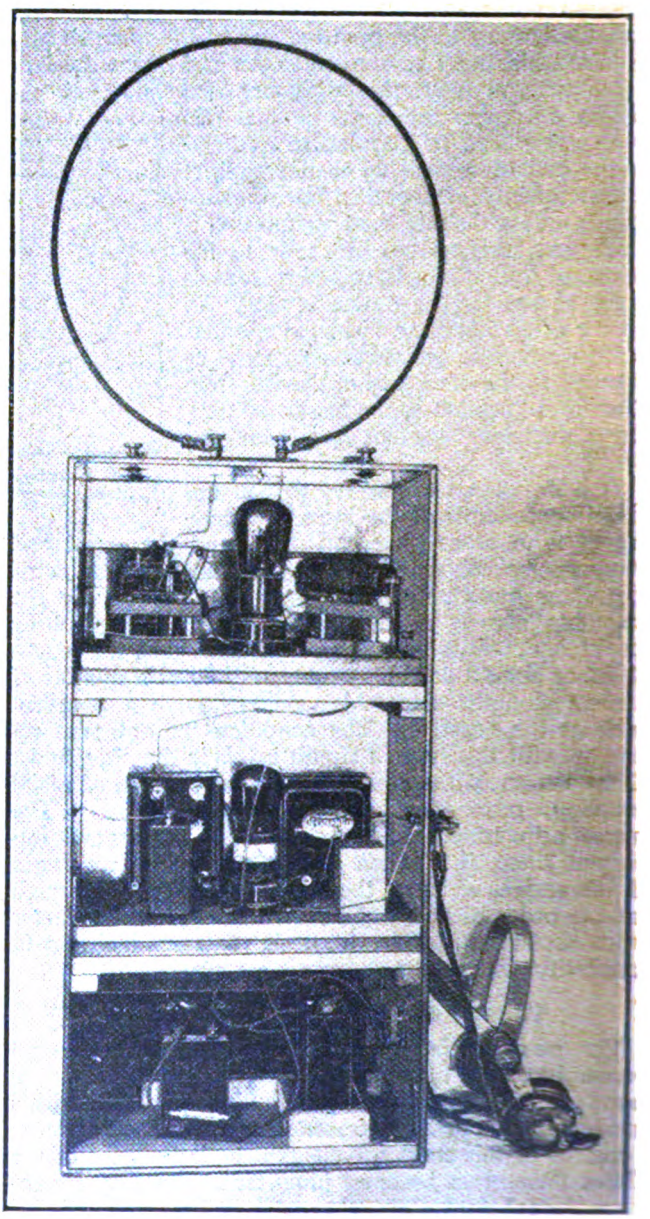

Fig. 3.—The loop receiver using the circuit shown in Fig. 2.

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Below 10 Metres.—

respectively (i.e., two condensers in series, each having minimum and maximum of 4 and 50 micro-microfarads).

Diameter of loop in inches.	Wavelength range in metres.
5	4.8-6.9
8	5.5-8.8
10	6.2-9.5
12	6.7-10.8

In order to ascertain the possibility of reducing the minimum wavelength by a reduction in the stray capacity of the first stage, some measurements were made of the capacity between the coil terminals and the effect of various components upon this capacity. The measurements were made by a substitution method using a standard variable air condenser and a wavelength of about 17 metres. With both tuning and retroaction condensers set to their minimum positions, the capacity between the coil terminals with the first valve in its socket was 9 and 12 micro-microfarads with the current on and off respectively. To this amount the base of the valve contributed 1 micro-microfarad, while the capacity of the valve itself in between its grid and anode was about 1.5 micro-microfarad, leaving about 7.5 micro-microfarads to be attributed to the wiring connections and their capacity to the screening box. The alteration of the retroaction condenser from its minimum to maximum position increased the capacity between the coil terminals by 5 micro-microfarads. The substitution of various grid leaks and choke coils in the detector valve circuit made no appreciable alteration to this capacity. It will be seen that the minimum capacity that can be obtained is limited by the capacity of the valve and its connections, and little reduction can be obtained by omitting the valve holder or by using a tuning condenser with a still lower minimum capacity than that at present in use (2 micro-microfarads).

The chief disadvantage of this limitation in the minimum capacity of the main tuning condensers is that the maximum must also be small, as no suitable condenser has yet been designed which incorporates both a small minimum and a relatively large maximum capacity. This limitation in capacity restricts the range of wavelengths which it is possible to cover with any one coil, but the above table indicates that there is no difficulty in making the receiver operate at wavelengths down to about 4 metres. When it is desired to proceed to still shorter wavelengths, it is an advantage to remove the stray capacity due to the screened box. In this way the same receiver, with the inductance coil reduced to a straight wire of No. 16 S.W.G. 2in. long, has been made to operate at 2.9 metres.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

EMPIRE BROADCASTS.

Sir,—Having read in your columns so many denunciations of the B.B.C.'s short-sighted short-wave policy, one finds it increasingly difficult to produce further arguments in the hope of persuading an early improvement in the situation. Apparently neither the B.B.C. officials nor the engineers responsible for 5SW have any sense of shame or interest in the station, otherwise 5SW would be proclaiming itself to the world at large as the short-wave unit of the richest broadcasting combination in the world, and proclaiming itself in no small voice. Several people already have shattered the excuse that 5SW is experimental. When one thinks of the number of stations that have started since 5SW came on the air, and have been immediate successes, one cannot but feel that the B.B.C. is letting us down rather badly. Anyway, how can a station pretend to be experimental which does not experiment with the most important item, the wavelength? Strangely enough, the engineers are so proud of its puny performance that they never bother to ask for listener's reports.

In my humble opinion the B.B.C. would do well to tell the Marconi Company that they have no use for such a poor effort as 5SW, and ask the Philips Radio people to build a permanent station, it would need no months of experiment! Any fool can see that a truly Empire station must broadcast simultaneously on two wavelengths, neither of which would be that used at present. I would suggest wavelengths of around 32 and 16 metres.

And now, you folks at home, are you in sympathy with the B.B.C.'s plea that they are not justified in spending your money on an Empire broadcaster? Of course you aren't! Then let us have a good lusty demand from you for a station you can be proud of. You are our only hope now. "GROWSER."

R.A.F. Base,
Calafrana, Malta.
September 9th, 1929.

WIRELESS THEORY.

Sir,—May I say how I appreciate the articles in *The Wireless World* on "Wireless Theory Simplified," by S. O. Pearson, B.Sc. I do not think that the subject could be treated in a simpler and more attractive manner. May there be many more of a similar nature.

I am one of that small number of readers who find your paper slightly too technical, but who, nevertheless, can find no other wireless periodical to come anywhere near to taking its place.

You will understand, therefore, how valuable a series of articles on the above subject will be to a

NON-THEORETICAL READER.

B.B.C. TRANSMISSIONS.

Sir,—I should like, if I may, to submit one or two observations about the quality of B.B.C. transmissions.

For at least one provincial listener, all the special occasions which the B.B.C. are in the habit of heralding with preliminary programme-puffs and pamphlets—the promenade concerts, symphony concerts, operatic performances—serve merely to mark so many *dies non* or rather "blank" nights; and this not because a plebeian ear disqualifies him from appreciating what the best people like, but because the quality of the transmission makes it impossible to listen to it with pleasure.

This state of affairs gives him a sense of grievance at all times. But what moves him to public complaint about it at this moment is his recent very keen enjoyment of "local" transmissions of orchestral music from the Festival Hall at the North-East Coast Exhibition. He has experienced wireless at or approaching its best for a few brief hours. And, naturally enough, he asks himself—and any-one else better able to supply an answer—why he can't be given the genuine thing always.

I believe that neither the engineer nor the musician would

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question the practical accuracy of some such classification of B.B.C. transmissions as follows:—

(a) First-rate. Direct or "local" transmissions.

Only those within "local" range of London receive transmission wholly of this quality. Provincial stations, other than Daventry, give only about 25 per cent. direct transmission.

(b) Second-rate. Daventry transmissions.

These suffer deterioration through the use of 70 miles of land-line.

(c) Third- to fifth-rate. Land-line relays.

The land-line may be anything from 100 to 400 miles in length, of varying character, and inadequately corrected. Besides the prime defect of frequency distortion and/or attenuation, these transmissions are vitiated also by background noise. It is impossible, even in the case of any one particular provincial transmitter, to set them down as being all of level merit. Relays by Newcastle, for instance, from the London Queen's Hall, seem, as judged by ear, to be inferior for some reason or other to those from the London studios.

Sixty per cent. of provincial transmissions of music come under this head.

(d) Sixth- to tenth-rate. Wireless relays.

These are re-transmissions by provincial transmitters of Daventry 5XX picked up by wireless. They combine, therefore, the defects of a short land-line, one receiver, and two transmitters, with the addition in varying degrees of atmospherics. Some 15 per cent. of provincial musical transmission is of this sort.

The conclusion to be drawn is that the majority of listeners receive as a rule third- to tenth-rate transmission.

Until a majority at least enjoy for the most part first-rate transmission it would seem premature to accept wireless as an authentic medium either of musical entertainment or of musical education. There is at present a case rather for denouncing it as de-sensitising the collective musical ear.

And can it be possible that the efforts of designers and manufacturers to provide sets giving straight-line reproduction have been so far and remain for the time being so much energy misdirected?

K. McCORMACK.

Newcastle-on-Tyne.

HIGH SPOTS.

Sir,—The *Humorist* recently had a radio article whose writer says that last year screen-grid valves and pentode coils (*sic*) were the "high-spot" of interest, and asks what it will be this year. I can tell him: it was the drum-controlled loud speakers.

H. E. ADSHEAD.

IDENTIFYING STATIONS.

Sir,—I have been much amused at the various efforts of broadcasting authorities and others to make the identification of stations an easy matter. All broadcasting stations are given a call-sign consisting of a combination of letters and figures, or letters only. Why not use them? and in this manner: Each station to send its call-sign three times in morse, slowly and distinctly, in the intervals. Listeners will not need to learn the code as, if sent in a proper manner, it would be an easy matter to copy the dots and dashes on paper and look up the code afterwards and at leisure.

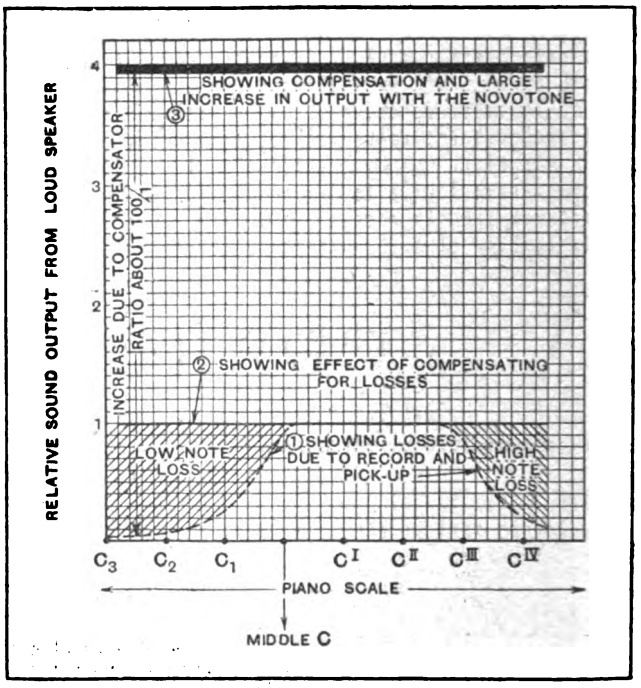
I claim that this simple and very obvious system would obviate all the various phonetic languages—hoots, whistles, ticks, gongs, and so forth—which each station now employs in a vain effort to make itself known.

S. W. CUTLER.

Ealing, W.5.

THE NOVOTONE.

Sir,—I should like to amplify your remarks on the above device which appeared in *The Wireless World*, page 380, October 2nd, 1929. The apparatus is termed a "filter" and it is also implied that a good pick-up requires no correction. The Novotone is in no sense a filter. It increases the voltage from the pick-up below 250 cycles and above 2,000 cycles. If the groove width below 250 cycles is constant (as it is in practice), it is necessary—even with a perfect pick-up—to compensate for the corresponding reduction in low frequencies. The Novotone gives accurate compensation from 250 cycles to 50 cycles. The requisite compensation above 2,000 cycles depends upon the pick-up, etc., and can be varied by means of a rheostat of 30 ohms or more.



The accompanying diagram shows precisely what happens when the Novotone is connected between the pick-up and the amplifier. With M.C. speakers having pronounced resonances below 100 cycles the Novotone causes a startling effect, which I leave the experimenter to discover for himself.

N. W. McLACHLAN.

BOOKS RECEIVED.

First-Year Electrical Engineering, by D. J. Bolton, M.Sc., M.I.E.E.—An elementary text-book of electrical engineering, including Ohm's law, electrical units, primary batteries and accumulators, magnetism, motors and generators, electrostatics, instruments, lighting, telegraphy and telephony, with a few notes on the elements of wireless telegraphy. Pp. 260, with 118 illustrations and diagrams. Published by Edward Arnold and Co., London. Price 5s.

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Electrical Wiring and Contracting.—A practical and authoritative work dealing with all branches of the trade, written by experts for electricians, contractors, and all engaged on installation work, and edited by H. Marryat, M.I.E.E., M.I.Mech.E. To be completed in about thirty weekly parts. *Part I* includes workshop science and the beginning of an article on drawing. Subsequent parts will include electricity and magnetism, A.C. and D.C. generators and motors, practical wiring, testing, heating and cooking, estimating and many other kindred subjects. Published by Sir Isaac Pitman and Sons, Ltd., London. Price 1s. each part (64 pages, with numerous illustrations and diagrams).

The "Motor Cycle" Diary for 1930, including, in addition to the usual diary memoranda, speed records, with space for amendments; monthly summary of running expenses; principal hills in Great Britain, with remarks on their special features. Published by Iliffe and Sons Ltd. Price, bound in leather with pencil, 1s. 6d. net or 1s. 7d. post free.

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Fenomeni Radioatmosferici, by Prof. Piero Ilardi.—A study of the nature and character of atmospherics, from observations recorded in various meteorological and geophysical observations (in Italian). Pp. 28, with 5 diagrams. Issued by the Servizio Radioatmosferico Italiano, Montecassino and Rome.

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READERS' PROBLEMS ANSWERED

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

"The Wireless World" Supplies a Free Service of Technical Information.

Converting a Portable.

I should like to convert a commercial portable 5-valve battery receiver with two aperiodic H.F. stages into an A.C. mains set for operation where a source of current is available; will you tell me if it is likely that any special "snags" are to be guarded against in converting the set, and if it is necessary to do anything beyond making the usual alterations to the low-tension circuits? J. L. P.

We would hesitate to offer any definite advice on this matter, but we cannot help thinking that you would find it extremely difficult to overcome the natural tendency towards instability which would manifest itself on replacing the existing valves by indirectly heated types, having a much better "figure of merit." It seems almost certain that the H.F. amplifier will lack stability, and that motor-boating will be produced unless elaborate decoupling devices are included in the low frequency anode circuits.

o o o o

A "Regional" Crystal Set.

I often use a crystal set for listening to the local station when loud speaker reception is not required, and after hearing the test transmissions from Brookman's Park have come to the conclusion that my present arrangement will be hopelessly lacking in selectivity when the twin stations start operations. I take it that a two-circuit aerial tuner will be the best, and should be greatly obliged if you could suggest any improvement to the conventional arrangement, bearing in mind the fact that I have a number of spare components, including variable condensers of 0.0003 *and* 0.0005 *mfd. capacity, which I should like to use if possible.* K. D.

We think you will find it difficult to better the arrangement shown in Fig. 1, which is an improvement over that usually suggested, in that it makes provision for reducing the damping effect of the crystal; this is achieved by joining the detector and phones across a portion only of the secondary inductance coil.

Strictly speaking, the best connection for the crystal tapping can only be determined by trial and error, as its position depends entirely on the characteristics of the detector. It will therefore be obvious that a simple single-layer winding, or perhaps a section-wound coil would be best for this circuit, but in practice good results are often afforded by the use of an efficient commercial centre-tapped plug-in coil; of course, the crystal connection is made to the mid-point.

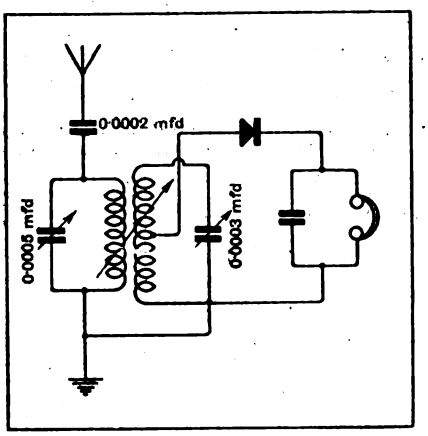

Fig. 1.—Highly selective circuit arrangement for a crystal receiver.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

Results comparable with those yielded by this step-down auto-transformer can be obtained by using an exceptionally large capacity for tuning the secondary circuit, but this is not usually convenient, particularly if it is desired to receive both of the twin stations, which will naturally transmit on wavelengths differing as much as possible.

o o o o

Tapping Litz Wire.

I am building a two-circuit aerial tuner similar to that included in several recent "Wireless World" sets, and have encountered a difficulty in making tapped connections to the secondary winding, which is of Litz wire. It would simplify matters greatly if it were permissible, instead of making connections to all the strands of the cable, to effect a junction to but a few of the conductors; would this course be permissible, or would it be better in the interests of efficiency to cut the wire at each point and to make a soldered connection to each and every strand? O. C. B.

In circuits of the kind under discussion—and, indeed, in most arrangements for which tapped Litz coils are used—it is is quite unnecessary to make connection with all the strands. In a tuned open aerial circuit where losses are bound to be fairly heavy, there is no point in taking special precautions, but you should be very careful not to break any strands.

o o o o

"Kit Set" Modifications.

Is there any reason why the "Wireless World Kit Set" should not be modified by the use of anode bend detection? It is realised that this alteration would entail one or two minor modifications; for instance, the detector-grid would be connected directly to the high potential end of the H.F. transformer secondary.

If you approve this alteration, I propose to abandon the use of reaction. P. A.

With the alterations you specify, the set should work quite well, with its detecting circuits altered for anode bend rectification. It must not be forgotten, however, that in its existing form it is essentially designed for grid detection, and we cannot help thinking that it would be rather a pity to alter it.

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Eliminator for the "Foreign Listener's Four."

I already have an H.T. eliminator capable of supplying approximately the voltages specified for the "Foreign Listener's Four." Do you think that it would be safe to use it, or would it be better to make up a special unit as described?

M. T. E.

The circuit of the set in question is such that it is not prone to interaction troubles, and, if your eliminator delivers sufficient current at approximately the right voltage and includes reasonably adequate smoothing arrangements, there is no reason why it should not be used with complete satisfaction.

o o o o

"Kilo-Mag Four" Pick-up Connections.

Will you please give me a circuit diagram showing how a pick-up may be fitted to the "Kilo-Mag Four" receiver? If possible, I should like to make the change-over by means of a single-pole switch mounted through the base of the screening compartment, and operate it through a rod by a knob mounted on the front panel. In addition, I should like to arrange matters so that the H.F. valves are switched off when the waveband switches are in the "off" position.

A. G. C.

This method of fitting a pick-up is to be recommended, and it is not difficult to devise a suitable method of connection. A recommended arrangement is shown in Fig. 2, which is drawn on the assumption that the switches at present used for waveband changing are so made that they have a definite "off" position.

You will see from the diagram that the extra switch is so arranged that it changes over the low-potential end of the detector grid circuit from its normal bias connection to the pick-up, which will naturally be connected to a less negative point on the common bias battery. An extra pole is added to the waveband switch S_3 (reference lettering corresponds with that in the original circuit diagram, Fig. 2), and is arranged so that the filament connections of the H.F. valve are broken when its arms are in a position intermediate between the sets of contacts.

o o o o

Potentiometer or Variable Resistance.

By mistake I recently purchased a ½-megohm potentiometer instead of a variable resistance of that value; will you tell me if it is possible to alter the internal connections to the terminals, so that the device may be used as a plain variable resistance?

R. T. C.

Unless a definite "off" position is required for your purpose, it is quite unnecessary to alter the component, and, to use it as a variable resistance, it will only be necessary to connect the external circuit to the terminal in contact with the movable brush contact (generally the centre terminal) and to either one of the other terminals—it is really immaterial which, but it is usual to choose the one which gives a decrease of resistance with clockwise rotation of the knob.

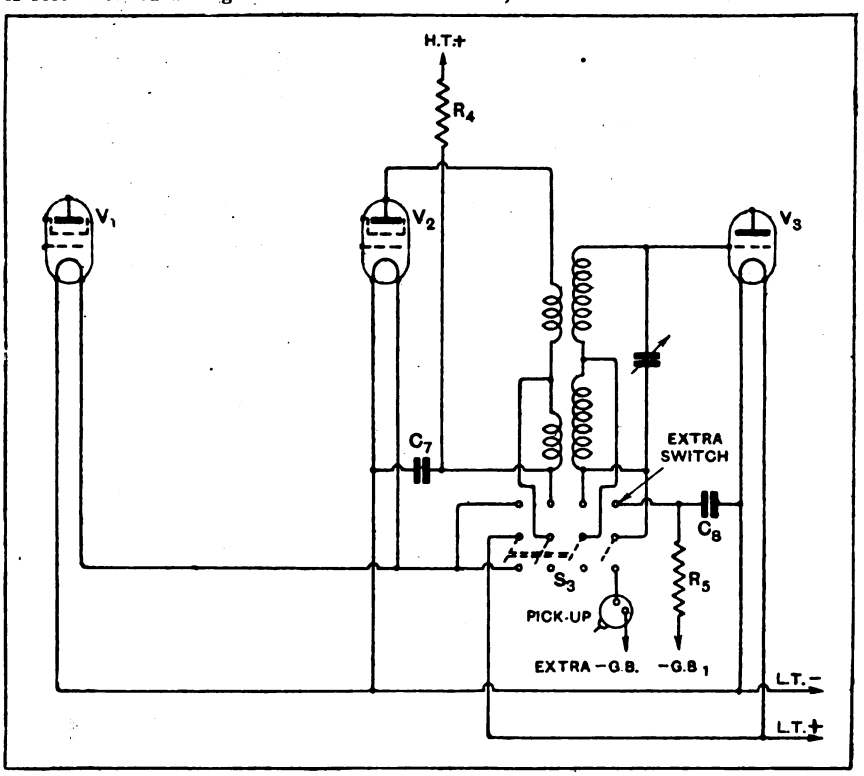

Fig. 2.—Method of connecting a gramophone pick-up to the "Kilo-Mag Four": an extra contact on the wave-change switch S_3 is arranged to break the H.F. valve filament circuits.

o o o o

Built-in Transformer Condensers.

For the "Kilo-Mag Four" I am using a transformer with a built-in condenser across the primary windings. Would it be best to remove it, or, alternatively, do you advise me to leave it in position and to omit the by-pass condenser connected between anode and filament of the detector valve?

C. N. S.

To be on the safe side, we think it would be as well to remove the condenser. Unless steps are taken to by-pass H.F. currents in the detector anode circuit, instability may be encountered, and it is hardly wise to omit the anode by-pass condenser, as you suggest.

o o o o

Testing in Safety.

My "Record III" receiver is nearing completion, and I should like to know what alterations are necessary to enable me to test the receiver with battery feed before connecting my mains unit.

R. P. C.

This receiver may be fed from a battery supply without any alteration whatsoever. The leads provided for connection to the low voltage A.C. input are connected across a 4-volt low tension accumulator; polarity is immaterial. You should assure yourself that this battery is capable of delivering a current of 3 amperes.

o o o o

Leave Well Alone.

Do you consider that it would be worth while modifying the "New All-Wave Four" by substituting a screen-grid valve for the present neutralised triode H.F. amplifier? If so, will you please give me a few hints as to how to proceed, bearing in mind that, as the set works very well as it is, I do not propose to make any change unless it is possible to do so satisfactorily without radical structural alterations?

C. R. G.

If you are using an efficient modern three-electrode valve in the H.F. position, it can safely be assumed that a magnification of at least forty times is being attained; unless comparatively elaborate screening arrangements are added, you are hardly likely to better this appreciably by fitting a screen-grid high-frequency valve; unless you are willing to make these alterations, we can hardly advise you to change your existing arrangements.

o o o o

The "Kilo-Mag Four": A Correction.

In the practical wiring plan of this receiver, the reference lettering on the two H.F. valve-holder filament terminals should be reversed; it will be obvious that the terminals "earthed" to the metal work should be lettered *r* and *t* to correspond with their connecting wires, which lead to L.T. negative. The valve-holder positive filament terminals, which are connected to the rheostat, should of course be lettered *s* and *u*.

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THE REGIONAL SCHEME.

OUR editorial in the issue of October 16th, under the title "Must the Regional Scheme be Scrapped?" has aroused some of our readers to wrath, whilst others are whole-hearted in their endorsement of our criticism of the power of Brookman's Park. The letters which we are receiving can, with very few exceptions, be divided into two classes; those whose receivers have hitherto been outside the range of efficient reception from the lower-powered 2LO transmitter in Oxford Street and who now get a satisfactory service on account of the higher power of Brookman's Park, and are enthusiastic in their support of the station; and those who have the misfortune to live nearer to Brookman's Park and find that much that they were hitherto able to listen to by way of a choice of programme is now denied to them because of the "wipe out" effect of the new station. These unfortunates look forward with apprehension to the commencement of the dual transmissions from the regional station.

Several letters have commented on the fact that the receivers described recently in *The Wireless World* have been designed so as to be sufficiently selective to overcome the disadvantages of the high power transmitter and that therefore there should be no occasion for worry. We agree that selective sets will go a long way towards solving the problem for those who want to listen to alternative stations, but the vast majority of the public are to-day using sets which are not sufficiently selective to give them, under the regional scheme, freedom to receive transmissions from abroad which they have hitherto enjoyed.

B.B.C. Programmes Only.

We know that those who have been responsible for developing the regional scheme hold the view that the listener should have the choice of two B.B.C. programmes from his local regional transmitter, and that he should neither be encouraged nor even permitted to receive any other station, but that from time to time the B.B.C. will put on for his benefit selected portions of the programmes of some of the foreign stations. Now the listener has, we feel, a right to say whether he endorses this policy or not, and whether he is content that his receiver should, by the action of the B.B.C., be rendered virtually incapable of receiving anything beyond the two programmes which the B.B.C. will provide. Our own conception of wireless does not, we fear, harmonise with this policy; the principal fascination of wireless, as we see it, lies in the ability to reach out and pick up programmes of all countries and all languages at will.

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OLYMPIA SHOW COMPETITION.

IN this issue we are able to announce the result of the voting of our readers in the Competition which we conducted in connection with the Olympia Radio Show, and we give the names of the receivers and other apparatus gaining the largest number of votes in each of the classes into which the exhibits as a whole were divided.

We are not yet in a position to announce the names of the winners of the cash and other prizes, offered by *The Wireless World* to those competitors whose votes agree most nearly with the views of the majority, but the task of arriving at these totals is a formidable one and some little delay is inevitable. Last year the total of entries was not so great, and it was then possible to make both announcements at the same time.

In our issue of November 13th we propose to illustrate and describe the winning apparatus in the Competition, and we feel sure that these descriptions will be of interest to all our readers.

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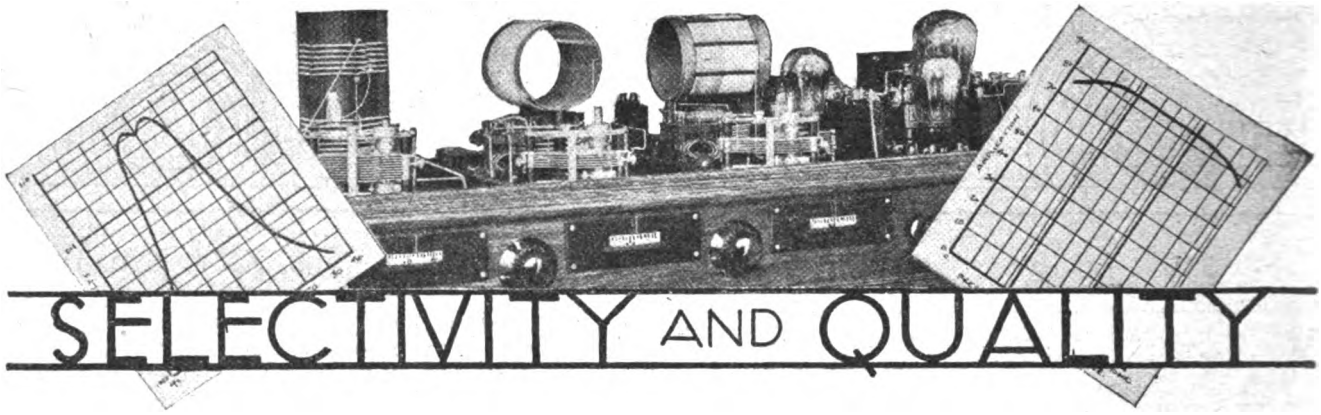

SELECTIVITY AND QUALITY

Using Band-pass Filters to Avoid Interference and Side-band Cutting.

By W. T. COCKING.

WITH the opening of the first Regional Station at Brookman's Park the problem of obtaining adequate selectivity has become greater than ever before. A method of tuning which of recent years has been somewhat neglected is that employing coupled tuned circuits, which in pre-broadcasting years was often used under the name of the three-circuit tuner. The use of this method, however, has been revived in a few modern receivers, a notable example being the "Wireless World Record III" set; it is also used by the B.B.C. in the transmitting circuits of the Daventry Experimental station.

The reason for its lack of popularity is due to the fact that in its old form it was very difficult to tune, there being three variable controls. Properly designed, however, as in the "Record III," it is no more difficult to handle than more conventional arrangements, and it offers several important advantages.

The great fault of all ordinary tuned circuits is that they reduce to a large extent the strength of the high notes in the received speech and music. This effect is well known, but the amount of the reduction is not so generally realised. The H.F. circuits of a receiver using a Mazda AC/SG valve as the H.F. amplifier will, under certain conditions, reduce a 5,000 cycle note by 89 per cent., when the carrier wavelength is 500 metres, and both the grid and tuned anode coils have inductances of 240 mH. and H.F. resistances of 5 ohms. On the lower wavelengths the loss is not so great, but it is still so serious that it will completely overshadow any normal loss in the L.F. portion of the set.

The selectivity of the arrangement is quite high, the strength of a signal at 40 k.c. off resonance will be only 1/500th of that at resonance; that is, the selectivity ratio is 500:1. Throughout this article the selectivities of different circuits will be compared by the ratios of the voltage on the grid of the valve at resonance and at a frequency differing from resonance by 40 k.c. The vartiation in strength over the side-band range (taken as the carrier frequency plus or minus 5,000 cycles) is expressed as a loss in percentage.

With the usual method of tuning by circuits in cascade no improvement in quality is possible without a corresponding reduction in selectivity, unless both the number of the circuits and the H.F. resistance of each are increased. While this is quite effective, it is not very economical, for the resistance of each coil has to be so high that the sensitivity of the receiver is very much reduced.

With coupled tuned circuits, or as they are more usually called, band-pass filters, high selectivity with a good measure of amplification and a high note loss of only about 10 or 20 per cent. can be readily attained. There are three methods of coupling the two halves of these filters, (*a*) by inductance, (*b*) by mutual inductance, and (*c*) by capacity, and the connections for such filters used in the aerial circuit are illustrated in Fig. 1.

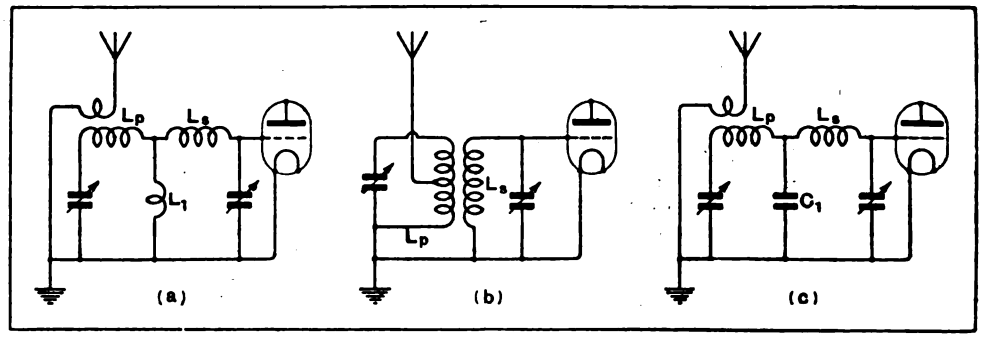

Fig. 1.—Three band-pass filter arrangements. (a) Coupled by inductance; (b) coupled by mutual inductance; (c) capacity-coupled.

Now it is a peculiarity of filter circuits of these types that they are tuned to two different frequencies at the same time. With inductance coupling, one of these frequencies is the same as the normal resonance fre-

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Selectivity and Quality.-

quency of either primary or secondary circuit alone, while the second resonance frequency depends upon the value of the coupling inductance L_1. Expressed algebraically,

the normal resonance frequency $f = \frac{1}{6.28\sqrt{LC}}$

the second resonance frequency $f_1 = \frac{1}{5.28\sqrt{C(L+2L_1)}}$

With mutual inductance coupling, there are still two resonance frequencies, but neither of these occurs at the normal resonance frequency. One is at a higher, and the other at a lower frequency as follows:—

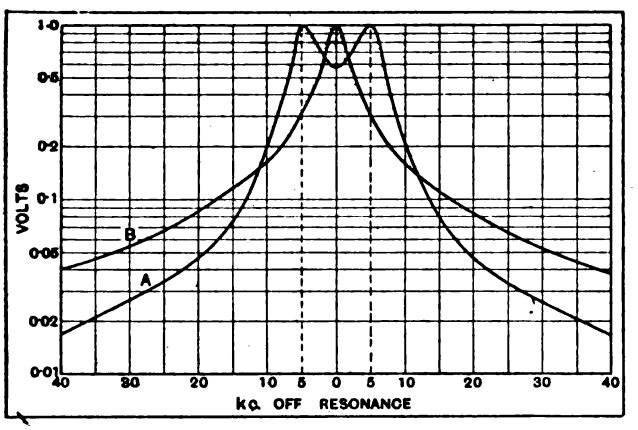

Fig. 2.—Curve A, filter in aerial circuit at 500 metres, 5 ohms coils. Curve B, single coil aerial tuned circuit at 500 metres, 5 ohms coil.

one resonance frequency $f_1 = \frac{1}{6.28\sqrt{C(L+M)}}$

the second resonance frequency $f_2 = \frac{1}{6.28\sqrt{C(L-M)}}$

It is this possession of two resonance frequencies which makes the filter so valuable; for the resulting tuning curve shows two peaks, the distance apart of which depends principally upon the value of the mutual inductance M, and to a smaller degree upon the resistance of the coils. See formula given in Appendix (1).

The results calculated from the formula show that the shape of the tuning curve is the same for both inductance and mutual inductance couplings. The chief fault of both types of inductance coupling, however, is that the peaks get further apart as the wavelength decreases, and, neglecting the effect of the resistance, the distance between them at 250 metres will be double that at 500 metres. Thus the selectivity on the lower wavelengths is reduced. With capacity coupling, on the other hand, the reverse takes place; and the distance between the peaks is less on the shorter wavelengths.

Curve A, Fig. 2, shows the resonance curve for a mutual inductance-coupled (or inductance-coupled) filter, where each coil has the same constants—240 mH., 5 ohms, the value of mutual inductance being 4 mH.—and the wavelength is 500 metres; while curve B is for an ordinary tuned coil in the aerial circuit, having the same constants. The curves in Fig. 3 are for the same circuits, but for a wavelength of 250 metres, at which the coil resistance is 10 ohms.

An inspection of these curves shows that with a wavelength of 500 metres (Fig. 2) at a frequency 40 k.c. different from the carrier the selectivity with the filter is much better than that with the ordinary tuned circuit. At frequencies nearer to resonance the filter is not quite so good; but the variation over the side-band range is 42 per cent., as compared with 69 per cent. for the single coil. The efficiency, however (see Table) is only about one-third.

The Intervalve Coupling.

The curves of Fig. 3 for the same circuits at 250 metres show that here again the filter is the better, but that the differences between the two circuits are less at this shorter wavelength. At 40 k.c. from resonance the selectivity with the filter is only slightly greater than that with the ordinary circuit, but the shape of the curves shows that at frequencies further from resonance than this it will be by far the more selective. The side-band variation is also less, being only 18 per cent. as compared with 15 per cent. for the single coil. The only fault of this curve (A) is that there may be a danger of receiving stations adjacent in wavelength to that of the desired station, as the peaks coincide with their wavelengths. This fault may be eliminated, as will be shown later.

The behaviour of a filter used as an intervalve coupling in place of the more usual tuned anode or tuned transformer will now be considered. In the Appendix is given the necessary formula (2) for calculating the amplification possible at any frequency.

Since the curves for a filter used in the anode circuit of a valve such as the Mazda AC/SG are very similar to those for the same filter used in the aerial circuit, it is unnecessary to give a series of curves, but Fig. 6, Curve A, shows one for an inductance-coupled filter at

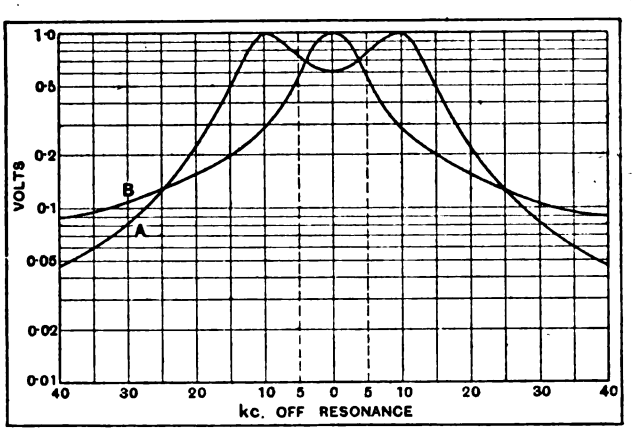

Fig. 3.—Curve A, filter in aerial tuned circuit at 250 metres, 10 ohms coil.

500 metres. The essential characteristics are given in the table, and it is curious that the selectivity is actually higher than when the same filter is used in the aerial circuit.

A comparison of the results for the filter used in the aerial circuit with those for it in the anode circuit shows

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Selectivity and Quality.—
that there is little difference as regards selectivity and efficiency, but that in the anode circuit it gives a smaller side-band variation.

Now, it will be observed that all these filters give a double-peaked curve, with the result that the high notes in the reproduced speech and music are accentuated. This is not undesirable, since most loud speakers are somewhat deficient in the upper register. There is no base cut-off, for the effect is similar to that obtained

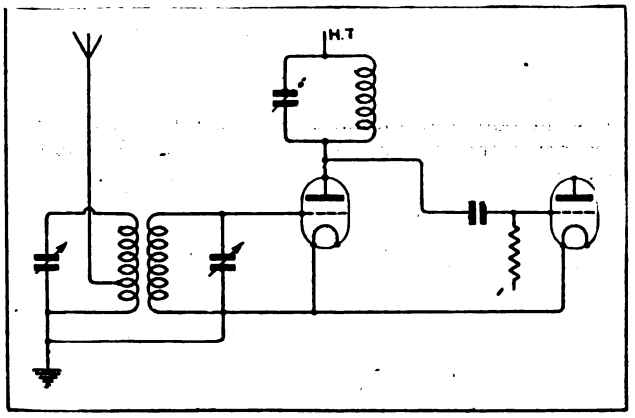

Fig. 4.—A curve with a single peak is obtained when using this circuit.

with an L.F. transformer having a rising characteristic. If this were the whole story it would be advantageous to use suitably designed filters in order to compensate for the loud speaker deficiencies. Unfortunately, however, such an arrangement would be difficult to handle, for it would be necessary to tune, not for maximum strength, but for a minimum occurring between two maxima. For ease in tuning, therefore, the overall curve must have only a single peak, and this can easily be obtained by using a tuned-anode intervalve coupling with a filter in the aerial circuit.

Avoiding Interference from Brookman's Park.

A circuit of this nature is shown in Fig. 4, and the overall tuning curve is the product of the individual curves for the filter and tuned-anode. Overall curves are given in Fig. 5 for the case when the components have the values given earlier; curve A is for a wavelength of 500 metres, and B for 250 metres; the figures for selectivity and amplification are given in the table.

At this point it is of interest to note a few characteristics of the filter circuit. When the H.F. resistance of the coils is raised sufficiently, the value of the mutual inductance being unaltered, the double-peaked curve will disappear and be replaced by a single very flat peak; and although the efficiency and selectivity are slightly lowered the amount is by no means as great as one would expect. This is shown in Fig. 6, where curves A and B are for identical circuits in the anode of an AC/SG valve, but the coil resistances are 5 and 10 ohms respectively. The figures for amplification are 71.5 and 56.7, for selectivity 54.5 and 41.5, and for side-band variation 34.5 per cent. and 2 per cent.! The improvement in the side-band variation is so enormous that in many cases the slight loss in amplification and selectivity is well worth while, particularly as the former is only low when compared with the results obtainable from the same valve and low-loss coils. In actual fact, it is rather higher than that obtained with the screen-grid valves of only a year ago.

An increase in the resistance of the coils of a filter in the aerial circuit gives similar results, but the alteration in side-band variation is not so marked. The effect of increasing the mutual inductance between primary and secondary circuits is to increase the distance between the peaks in the curve, and in many cases to decrease the side-band variation and efficiency. Lowering the value of the mutual inductance will increase both the selectivity and efficiency up to the point where the single-peaked curve is obtained; it will, however, introduce more high-note loss.

When designing any receiver it is advisable to make the aerial circuit as selective as possible, otherwise jamming of a peculiar kind may be obtained. When listening to a weak signal on a wavelength quite different from that of the local station, no matter how selective the intervalve couplings may be, if the aerial circuit is unselective the local station may cause considerable jamming. This is a rather neglected side of the selectivity question, but one which may be of particular interest to those living near a high-power station. Jamming of this kind is due to the H.F. valve. If the valve is overloaded, or its characteristic curved, it will rectify the voltages produced by the strong local station,

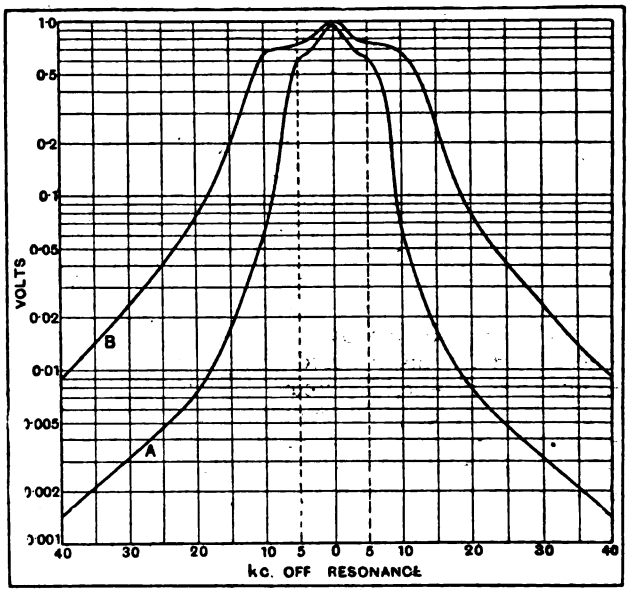

Fig. 5.—Curve A, filter in aerial circuit followed by tuned anode, 5 ohms coils at 500 metres. Curve B, as curve A, but 10 ohms at 250 metres.

and the resulting low-frequency currents will modulate the carrier of the desired station. The result is that the local station is heard, for it will actually pass through the following tuned circuits as a signal of the wavelength to which they are tuned.

A similar form of jamming is obtained under the same conditions if the aerial tuning is very flat. Suppose that the set is tuned to 1,500 k.c. and that the aerial tuning is so flat that it allows a fair proportion

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Selectivity and Quality.—of the voltage set up by the signals of two stations working at 700 k.c. and 800 k.c. to reach its grid. These voltages will be rectified by the H.F. valve and will produce a variety of beat frequencies, one of which will be equal to the sum of the two original frequencies.

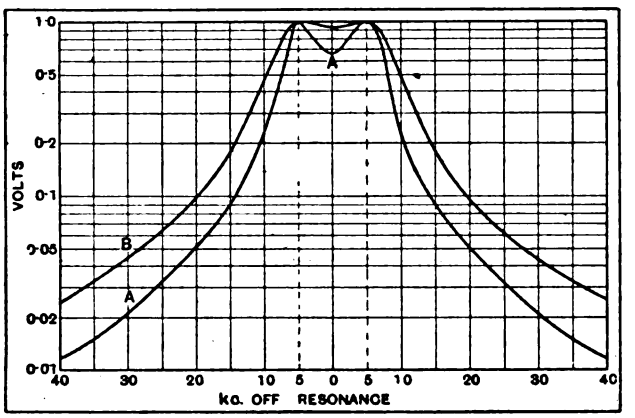

Fig. 6.—Curve A, filter with 5 ohms coils at 500 metres in anode of AC/SG valve. Curve B, as curve A, but 10 ohms coils.

that is, 1,500 k.c. Thus, not only will the desired station be heard, but in addition a jumble of two other stations; and this no matter how selective the tuned intervalve couplings may be.

Jamming of this character is frequently obtained, and blamed upon the unselective properties of the set, whereas the fault lies rather in the characteristics of the H.F. valve. The cure is always to work the H.F. valve upon the straight part of its curve, and to provide as selective an aerial tuning circuit as possible. The former necessitates a fairly high H.T. voltage and the correct negative grid bias, and the avoidance of those forms of volume control which alter the characteristics, such as filament control, control by alteration of the anode, screen-grid or control grid voltage.

A selective aerial circuit necessitates some form of band-pass filter if excessive side-band variation is to be avoided. For this reason, therefore, it is recommended that if tuning by a combination of filters and single-tuned circuits be used a filter should always be included in the aerial circuit. For volume control a high-resistance potentiometer shunted across the tuned input circuit is probably the best, as used in the "Megavox" receiver.

Coming now to practical considerations, the great fault of both inductive and capacitative couplings is that each coil in the filter must be completely screened. With mutual inductance coupling, however, it is only necessary to screen the filter as a whole, but it is a little more difficult to obtain the correct degree of coupling between primary and secondary circuits. A very good approximation to the correct coupling can be found as follows: Tune both primary and secondary circuits to a fairly weak station with very loose coupling between the coils; then increase the coupling just beyond the point at which the signals are at their loudest. If low-resistance coils are used a double tuning peak should be just obtained as the ganged tuning condensers are rotated; but if this is found with high-resistance coils the coupling is too tight. Ganging the condensers is quite easy, and is essential to the proper operation of the filter; the initial adjustments are best carried out with very loose coupling between the coils.

The Use of Solid Wire Coils Preferable.

If desired, reaction may successfully be applied to the secondary coil of a filter. It affords a useful increase in both the amplification and selectivity, and it does not seem to cause nearly so much distortion as with ordinary circuits. The effect is to decrease the coil resistance, and, in theory, this should actually increase the strength of the high notes!

In the accompanying table will be found the essential figures for magnification, selectivity, and side-band variation for all the circuits mentioned earlier; and, in addition, those for an H.F. amplifier at a wavelength of 500 metres, in order to show the possibilities of the filter circuit in a multi-stage amplifier. The circuit diagram of such an amplifier is shown in Fig. 7, from which the method of connecting a filter as an intervalve coupling can be seen. A receiver built in accordance with normal present-day practice would have only three tuned circuits, and, as a consequence, not only would the selectivity be much less, but the high-note loss would be very high indeed.

Lest the filter be condemned on the grounds of expense, it is worthy of note that this need be no higher than that of a Litz wound coil tuned by a single high quality condenser. Coils of this type are usually unsuited to the filter characteristics, and small solid-wire coils which can be made for a few shillings are often the most satisfactory. As highly efficient coils are not used, the small variable condensers of the type made for portable sets are admirably adapted for tuning. Certain of these can be obtained in a form eminently suitable for ganging for about 5s. each.

Circuit.	Wavelength.	Magnification.	Selectivity.	Side-band Variation.
Filter in aerial circuit, 5 ohm coils	500	53.8	36.7	42%
Single tuned aerial, 5 ohm coil ..	500	178	25	69%
Filter in aerial circuit, 10 ohm coils	250	53.6	12.9	18%
Single tuned aerial, 10 ohm coil ..	250	180	11	52%
Filter in anode of AC/SG, 5 ohm coils	500	71.5	54.5	34.5%
Filter in anode of AC/SG, 10 ohm coils	500	56.7	41.5	2%
Filter in aerial, followed by tuned anode, 5 ohm coils and AC/SG valve	500	11,100	740	39%
As above, but 10 ohm coils ..	250	19,000	108	25%
Anode filter and tuned anode with 10 ohm coil, aerial filter with 5 ohm coils. Two H.F. with AC/SG valves	500	340,000	17,500	29%

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Selectivity and Quality.—

In conclusion, the writer would say that, in his opinion, anyone once using properly designed filters for tuning will never go back to the ordinary cascade tuning circuits. Not only is the selectivity greater, but the improvement in quality is so great that it must be heard to be realised; and, in practice, the loss in amplification is not so noticeable as the figures would indicate. To those troubled by interference from the powerful transmissions of Brookman's Park the trial of one of the band-pass filters already described is suggested.

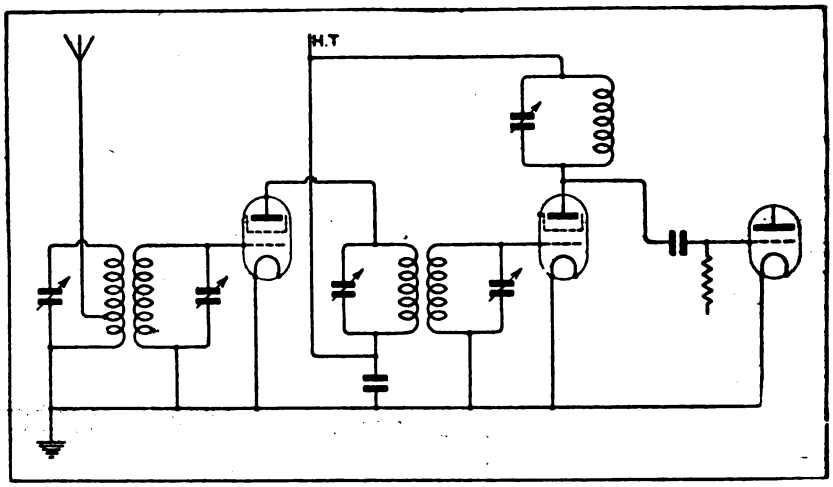

Fig. 7.—A high-frequency amplifier having aerial and inter-valve filters.

APPENDIX.

(1) The following formula may be used to calculate the voltage e, impressed upon the grid of a valve at any frequency for a given voltage E, applied in series with the primary circuit.

$$e = \frac{EM}{C\sqrt{\left[\left\{R^2+\omega^2M^2-(\omega L-1/\omega C)^2\right\}^2+4R^2(\omega L-1/\omega C)^2\right]}}$$

where M = mutual inductance in henrys.
L = inductance of one coil in henrys.
C = capacity of one condenser in farads.
R = effective H.F. resistance of coil in ohms.
e = voltage developed across secondary tuning condenser.
E = voltage applied in series with primary circuit.

For inductance coupling the above formula is modified by substituting L_1, in henrys, for M; and the value used for L should be the inductance of one tuning coil plus the inductance of the coupling coil L_1.

It should be noted that this formula is accurate only when both primary and secondary circuits are identical; that is, when $L_p = L_s$, $C_p = C_s$ and $R_p = R_s$.

(2) Formula for calculating amplification possible at any frequency with filter used as intervalve coupling. The symbols have the same meanings as before, and μ and R_a are, of course, the amplification factor and anode A.C. resistance of the valve, respectively.

$$A = \frac{M}{\omega C^2\sqrt{\left[\left\{R_a(R^2+\omega^2M^2-(\omega L-1/\omega C)^2)+\frac{LR}{C}\right\}^2+\left\{(\omega L-1/\omega C)\left(2RR_a+\frac{L}{C}\right)-\frac{\omega M^2}{C}\right\}^2\right]}}$$

"THE WIRELESS WORLD" OLYMPIA SHOW COMPETITION.

Results of the Ballot.

WE are now in a position to announce the results of *The Wireless World* Competition arranged in connection with the Olympia Radio Show, in so far as giving the names of the winning sets and other apparatus in the various classes into which the exhibits at Olympia were divided.

We shall not be able to announce the names of the winners of the cash and other prizes until a little later, as the task of arriving at the totals for this purpose has not yet been completed.

It will be remembered that, in connection with the voting, we divided apparatus into various classes, which were defined as follows:—

(1) Complete receivers of five valves or more—that is to say, receivers exclusive of loud speaker and batteries—unless these should happen to be incorporated as part of the receiver.

(2) Complete receivers of four valves or less, similarly defined.

(3) Batteries of all kinds, including accumulators for both high tension and low tension.

(4) Mains supply units, both D.C. and A.C., and including those which provide filament heating circuits.

(5) Loud speakers of all types.

(6) Valves.

(7) Other apparatus not classified above, also amplifiers, component parts, such as transformers, condensers, tuning coils, resistances, etc., etc.

In addition, readers were asked to vote for what was considered to be the single outstanding exhibit at the Show. In our issue of November 13th we are arranging to illustrate and describe the winning apparatus in the various classes.

OUTSTANDING SINGLE EXHIBIT AT OLYMPIA.

"Mazda" Screen Grid A.C. Valve.
The Edison Swan Electric Co., Ltd.

WINNING CLASSIFIED EXHIBITS.

Class 1.
A.C.7 Receiver.
Burndept Wireless (1928) Ltd.

Class 2.
Four-valve Receiver, All-electric, No. 2511. Philips Lamps Ltd.

Class 3.
Type WY.10 Exide H.T. Accumulator.
The Chloride Electrical Storage Co. Ltd.

Class 4.
Ecko Combined A.C. Eliminator, Type C2A. E. K. Cole, Ltd.

Class 5.
Moving Coil Loud Speaker.
Ferranti, Ltd.

Class 6.
"Mazda" Screen Grid A.C. Valve.
The Edison Swan Electric Co. Ltd.

Class 7.
The Novotone. Gambrell Radio Ltd.

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Factors in Design.

By F. L. DEVEREUX, B.Sc.

MANY methods, widely divergent in principle, have been suggested for converting the mechanical energy from a gramophone record into electrical energy in a suitable form for amplification; but, for various reasons which need not receive our consideration at the moment, only one type has survived commercially, viz., the electromagnetic pick-up. Fig. 1 shows the principle of an early form of electromagnetic pick-up which may be referred to as the "single-acting" type in which a vibrating reed varies the magnetic flux between two pole pieces *situated at one side only of the reed*. The single-acting pick-up has, however, given place to the differential or "double-acting" type shown diagrammatically in Fig. 2 in which the reed is placed symmetrically between pole-pieces *situated on either side of the reed*.

The advantage of the latter arrangement will be better appreciated if we first study the disadvantages of the single-acting principle. In the first place, serious amplitude distortion is caused by the fact that the flux varies as the square of the distance of the reed from the pole pieces. Secondly, the whole of the flux passes through the reed and may cause saturation, and, thirdly, as the attractive force is exercised in one direction only, a heavy reed with a powerful restoring force is necessary to prevent it falling on to the pole pieces.

Principle of the Balanced Armature.

In the case of the differential movement, the flux in the armature at rest is zero as the diagonal fluxes from the pairs of opposite pole-pieces cancel out (see Fig. 3(a)). When the armature is displaced (Fig 3(b) and (c)) the greater part of the flux flows in one direction, thus inducing an E.M.F. in the coil C (Fig. 2), but a certain residue still flows in the reverse direction, and this tends to annul the square-law effect mentioned in connection with the single-acting pick-up. The cancellation is, however, incomplete, and amplitude distortion still persists. Fortunately, it is now reduced to the degree where it becomes useful in compensating for the restriction in amplitude of the low notes on the average record.[1] The tendency for the armature to stick over on the pole pieces is also present in the differential movement but to a much smaller extent. There is no necessity to strengthen the reed to combat this force, and the necessary restoring force can be applied by the rubber damping pads (D in Fig. 2).

The differential movement, then, provides a practical method of reducing *amplitude* distortion to a manageable quantity. A much more difficult problem is that of *frequency* distortion. This resolves itself largely into a question of resonance in the reed itself. Now any vibrating system involving mass and a restoring force will resonate at one frequency, possibly more than one if harmonics are present. The frequency of the principal or fundamental resonance will be inversely proportional to the mass and directly proportional to the restoring force. In order to produce a pick-up of good characteristics this principal resonance should lie outside the range of fundamental frequencies used in speech and music. It is impracticable to arrange for the resonance to occur below, say, 30 cycles, therefore we must endeavour to raise it above 3,500 cycles. To do this the mass of the moving parts must be reduced to a minimum and/or the restoring force increased. The restoring force generally takes the form of rubber pads (D in Fig. 2), which also absorb a certain amount of energy, and thus damp down the resonance peak in the response curve. Record wear, however, limits the restoring force and degree of damping we can employ.

Reed Resonance.

The correct procedure, then, in raising the principle resonance above 3,500 cycles is to start with the reed and to reduce its mass to the lowest possible figure, and then to add just sufficient restoring force in the form of rubber damping to raise the frequency to the required value and to hold the reed symmetrically between the pole pieces. When dealing with the reed it must not be forgotten that the needle holder and set-screw are an integral part of the vibrating system and must be made as light as possible. In the B.T.H. pick-up, for instance, the set-screw coincides with the pivot axis (P in Fig. 2) thus reducing its moment of inertia about the point P.

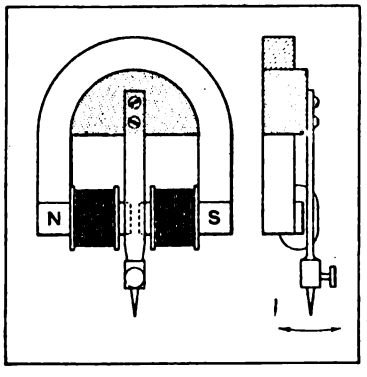

Fig. 1—Single-acting or unbalanced armature pick-up.

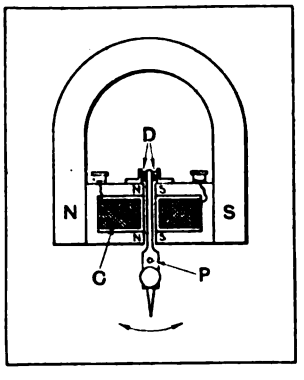

Fig. 2.—Differential or balanced armature pick-up.

[1] See p. 177 of the August 21st issue.

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Gramophone Pick-Ups.—

The lightening of the moving parts has been carried to its logical conclusion in the new Burndept and Lissen pick-ups in which the needle itself forms the vibrating armature and carries the magnetic flux. Naturally, the characteristics of such pick-ups must depend on the type of needle employed, but in the ordinary balanced-armature instrument the effect on the characteristic is small, though the general level of the output may be considerably modified. This is illustrated by the curves in Fig. 4, which are the result of actual measurements on an experimental pick-up with two different types of needle. The general form of the curve remains unchanged, but the resonance in curve A is about 400 cycles lower than in curve B, while the general level of output is nearly doubled. The lowering of the resonance in curve A is due to the extra mass of the thick Tungstyle needle.

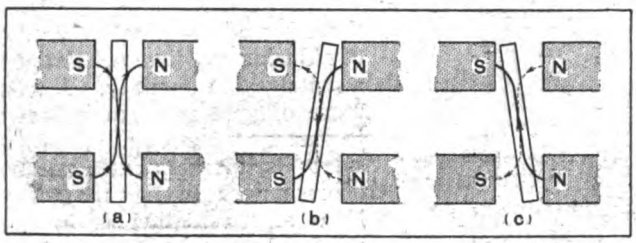

Fig. 3.—Illustrating the principle of the differential or balanced armature.

As a guide to the relative outputs to be expected from various types of needle the following figures, the results of some measurements with H.M.V. needles, are given.

Needle.	Relative Output. (Per cent.)
Tungstyle Extra Loud Tone	100
„ Loud „	90
„ Soft „	80
Steel Extra Loud Tone	85
„ Loud „	80
„ Half „	75
„ Soft „	45

Although the Tungstyle needles give a good output and will play up to 250 records without renewal, their comparatively high mass tends to bring the armature resonance within the range of audibility. The steel " Half Tone " needle is a good compromise for all-round use with electrical pick-ups; its weight is not excessive, yet there is little loss of energy in transferring the record vibrations to the armature.

The three factors most essential to the successful design of an electromagnetic pick-up may therefore be summarised as follows:—

(1) A symmetrical arrangement of the magnet pole pieces to give differential vibrations of flux in the reed or armature. Provided the armature is accurately centred, amplitude distortion will be reduced to a level at which it can be turned to a useful purpose, while the restoring force required to hold the armature in a central position will be small.

(2) An armature of the smallest possible dimensions in which the best distribution of mass to give a small moment of inertia has been attained without appreciably affecting the efficiency of the magnetic circuit.

(3) The restoring force and damping must be adjusted to compromise between record wear, the frequency of the principal reed resonance, and the peak value of this resonance.

Numerous minor problems follow in the train of these three indispensable conditions. For instance, the small reed demands a large and heavy permanent magnet if an adequate voltage output is to be maintained, and this means increased record and needle wear. Actually, record wear is more a question of the mass and damping of the reed than of the downward pressure of the needle. In fact, damage to the record groove is more likely to occur with a light pressure due to the tendency of the needle to jump the groove. Wear of the *bottom* of the groove due to pressure is unimportant compared with damage to the *sides*, which do the work of transferring the sound energy to the needle. In the writer's experience too little weight on the needle point is a prevalent source of distortion, and where the tone arm is fitted with an adjustable counterweight, best results are almost invariably obtained with the maximum available pressure.

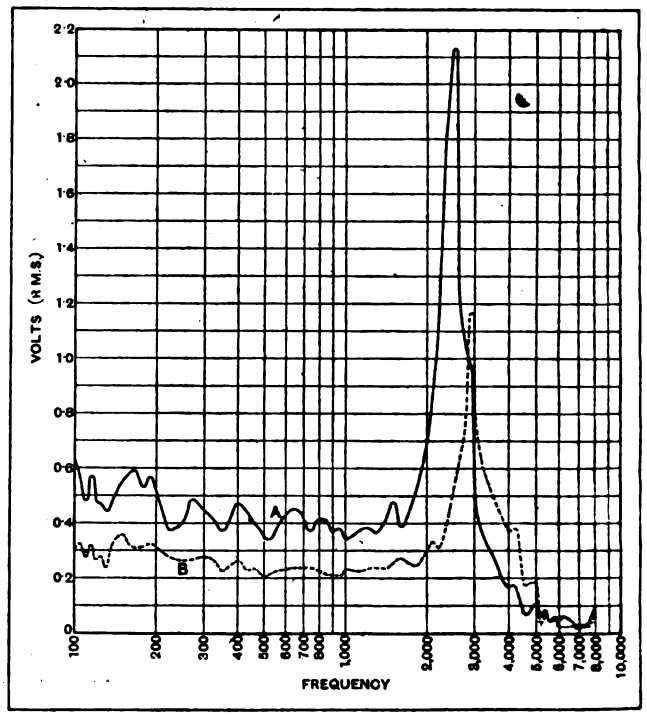

Fig. 4.—Output characteristics of experimental pick-ups, (A) with Tungstyle soft tone needle, (B) with steel soft tone needle.

Tone arm resonance should also be taken into account, though its effect on the output characteristic will not be appreciable until the pick-up movement itself is well-nigh perfect.

Now that standard frequency records are available to the public all the foregoing points can be investigated experimentally, and there is no longer any excuse for the manufacturer who continues to market an inferior product.

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Impressions of the Radio World's Fair.

By OUR SPECIAL CORRESPONDENT.

In the following report readers will be able to draw some interesting comparisons between the latest British and American practice in receiver design. U.S. broadcasting conditions have hitherto given manufacturers across the Atlantic unrivalled experience in producing selective receivers, but their lead in this direction is now being seriously challenged by the British-made article.

THAT the American broadcast receiver has almost become a standardised article was the impression gained by a visit to the sixth annual Radio World's Fair, held at Madison Square Garden, New York City, at the end of September.

Just as different makes of car now differ only in comparatively minor details, so with the American broadcast receivers of the different manufacturers. The screen-grid tetrode is almost universally used for the radio frequency amplifier stages. There are usually four tuned circuits, including the input stage. All the sets have single tuning control with an additional knob for controlling volume and usually a third control for adjusting the input circuit, which contains the antenna. This adjustment is not only necessary to cater for different antenna structures, but also to a small extent for different wavelengths.

Ganged Tuning in Evidence.

The tuning of the stages is carried out by means of a gang condenser. Components of this kind can be manufactured by mass-production methods, so that individual condensers do not differ from one another by more than one or two micro-microfarads on any part of the scale. Using a condenser aerial the step-up obtained by turning the induced E.M.F. into a potential difference across a tuned circuit will depend on the value of the capacity across the aerial. In order to eliminate this effect, a variometer tuning is employed by some manufacturers on the input circuit. There are a number of other different types of input circuits which endeavour to correct this inherent defect of gang condenser tuning, but none gives perfect tuning of the input circuit over the whole wavelength range. This difficulty could be overcome by employing an

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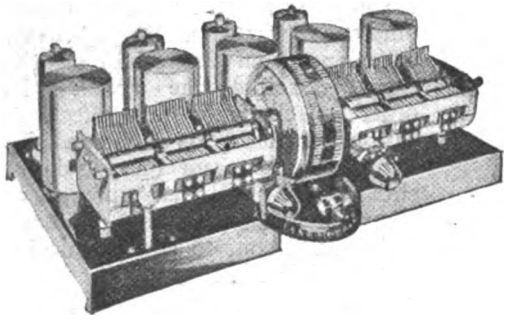
New York Radio Show.—

untuned input, but in such a case the amplification of the set would be considerably reduced, and if this were compensated for by the insertion of another valve the ratio of valve noise to signal noise would be very considerably increased.

The concert-hall "Grebe," one of the best-known American receivers. Three S.G. valves are employed, but only one stage of L.F. amplification. A gramophone pick-up is included.

All the sets on view at the Show were very compact, and each stage was carefully screened. *In American receivers reaction control is absolutely taboo.* The sets contain five to seven valves, often using separate heaters in order to reduce the A.C. hum of the supply, practically all the sets being fitted with a power pack suitable for A.C. mains. In such conditions, of course, it is not necessary to economise in filament voltage and most valves work on a five-volt filament. Many sets are fitted with automatic volume control, an arrangement by which, if the carrier amplitude is large, the overall amplification of the set is automatically reduced. If such an arrangement were perfect, all stations transmitting with the same percentage modulation would produce the same output intensity for a given setting of the volume control. In practice, the arrangement is not perfect, but is very convenient.



The "Grebe" receiver contains no fewer than six tuned circuits all controlled by a single knob.

Automatic Tuning.

Although the space available in the exhibition was not so large as that at Olympia, there was a comprehensive display of sets and components fully representative of the latest practice in American radio. About 300,000 people visited the Show during the week it was open, an increase of 50,000 over last year.

The moving-coil loud speaker fitted as standard in all the "Grebe" models.

The fact that orders were booked for no less than six million pounds sterling is sufficient indication that radio in the U.S. is in a flourishing condition.

The genius of the American manufacturer in the production of labour-saving devices was strikingly exemplified in nearly all of the well-known models. Knobs and dials, switches, etc., were conspicuous by their absence, two small controls harmonising with the general ensemble of the set being sufficient for tuning and control of volume. Many sets have automatic tuning, such as the Zenith and the Earl receivers. The latter is fitted with a device which enables the listener to choose a number of stations by first tuning them in in the ordinary way; by pressing a knob at each point of tune the mechanism is locked to that particular station. This knob moves in a horizontal slot under the tuning device, whilst above the slot are a number of name plates for logging the particular stations chosen. When a certain number have been tuned in and locked, it is merely necessary to slide the lever along the slot to register with the station logged there, and pull out the knob, when the required station is perfectly tuned in, no further adjustment being necessary.

The Edison receiver possesses another automatic tuning device which gives out a flash of light when the desired wave is obtained. Other receivers are fitted with automatic volume controls, automatic voltage regulators, and other details making for easy operation and fool-proof working.

Screening in practically all the American sets has reached a high state of perfection. There is no wire to be seen, all the connections

A home edition of the "Grebe" receiver.

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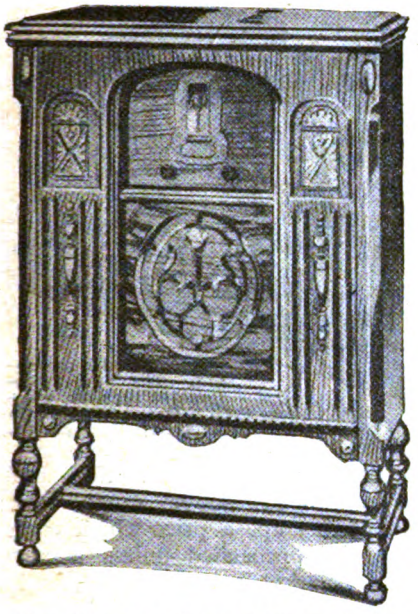
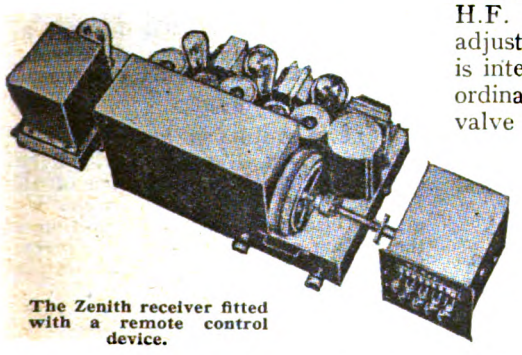
New York Radio Show.—

being made by "bunching" leads under sub-panels and double base plates (one cannot say "boards" as there is practically no wood or ebonite to be seen otherwise than in the actual cabinets). Every component is encased in a metal cover, excepting perhaps the valves, and the appearance of the chassis is extraordinarily neat and business-like. In several sets even the valves are covered. The "First National" receiver, for instance, suggests an armoured car. Its chassis is built of cold rolled steel, silver-plated, and not a connection is visible. The four S.G. H.F. amplifiers are all covered with metal frames.



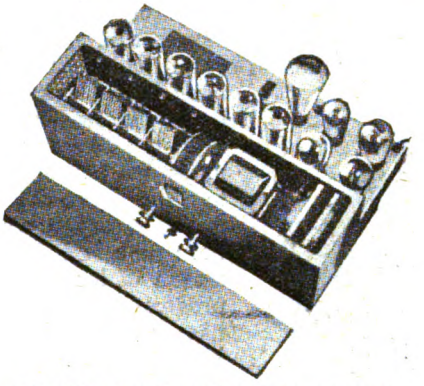
The eight-valve Zenith instrument, incorporating three S.G. valves, anode bend detector and double push-pull output. Full power equipment is included.



The Zenith receiver fitted with a remote control device.

In the realm of loud speakers the moving coil type reigns as practically standard. One departure from this type at the Show was the "Kylectron" instrument with a rather large chassis of the condenser type carrying a grid of aluminium sheet covered on one side with tin-foil. This speaker is supplied as standard with the "Peerless" receivers, which are of the luxury class, selling at between £40 and £120 without valves. Several "balanced armature" loud speakers were on view, besides all shapes and sizes of exponential horns. One of the largest had an air column of 10 feet and weighed 45 lb.

Component parts were noticeably few, and even separate battery eliminators were rare, these being included in the majority of the receivers exhibited.

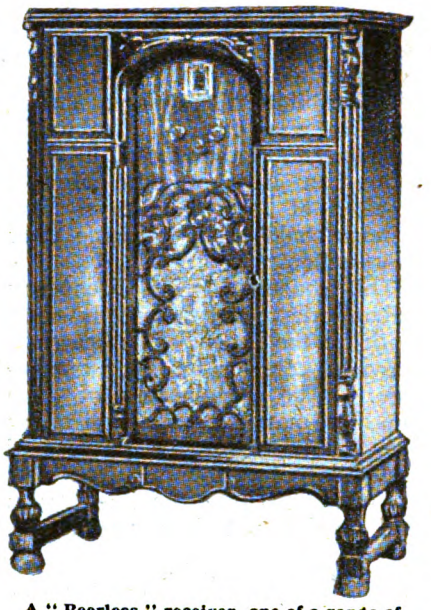


The "Peerless" receiver as incorporated in the most expensive models.

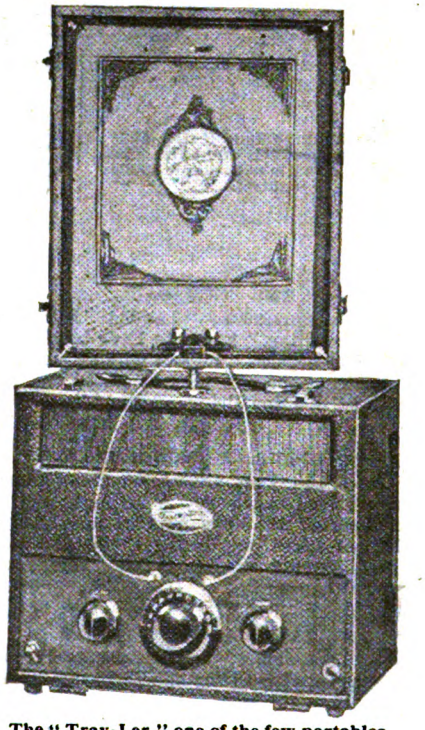
An interesting item among the "gadgets" was described as "a built-in high impedance link circuit H.F. coupler, with automatic self-adjusting grid bias." The device is intended for the conversion of an ordinary receiver to screen-grid valve working and consists of an external filament transformer, resistances, etc., together with a perforated metal cover for the valve.

The astonishing paucity of portables was a subject of comment at the Show. The "Trav-Ler," one of the few exhibited, included a loud speaker of the horn type.

The lower floor of the Exhibition was devoted to numerous scale models of transmitting and receiving stations. A full size studio was in use and visitors were able to watch the performance of broadcast programmes which were sent out over the networks of the National Broadcasting Company and the Columbia system. Picture trans-



A "Peerless" receiver, one of a range of luxury sets, some of which embody a loud speaker of the condenser type known as the "Kylectron." Three screen-grid valves are used, with anode bend detection.



The "Trav-Ler," one of the few portables at the Show. Although five valves are included, the price is just under £10.

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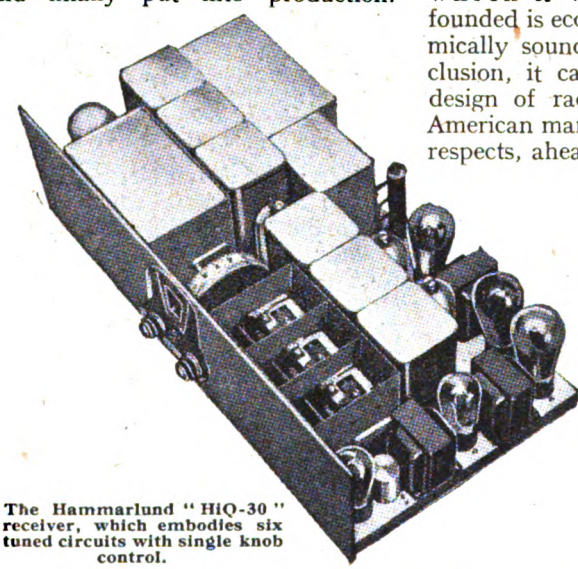
New York Radio Show.—

mission and reception was well demonstrated.

One exhibit which deserves special mention was that of the Radio Frequency Laboratories, who showed a large number of sets divested of their cabinets so that visitors could easily examine their construction.

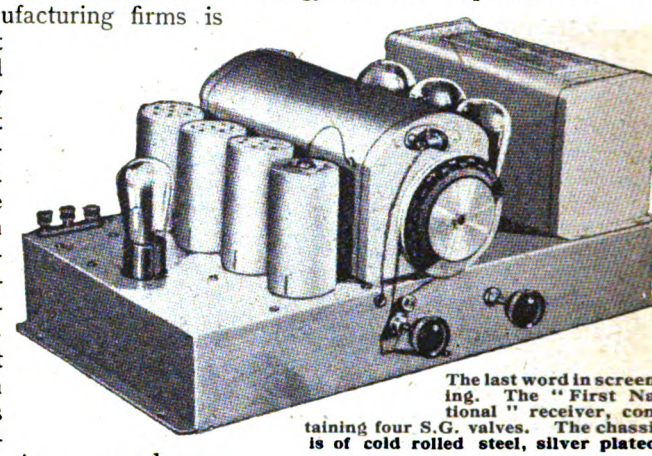
This concern, Radio Frequency Laboratories, carries out research work for the benefit of its licensees, providing designs for set manufacture. The engineers of the licensees may alter the designs as they think fit for the purpose of facilitating production. The sets are then tested in the laboratories and finally put into production.



The Hammarlund "HiQ-30" receiver, which embodies six tuned circuits with single knob control.

The licensees can call on the Laboratories at any time for any consulting and engineering service. In this way the research work of a number of manufacturing firms is concentrated at one point, and can consequently be carried out more satisfactorily and at a cheaper price than if each firm had its own research organisation. The success of the undertaking shows that the basic idea on which it was founded is economically sound.

As a general conclusion, it can be said that in the design of radio receiving sets, the American manufacturers are, in some respects, ahead of the British. They have been working under different conditions. The enormous market open to the American manufacturer has been the chief reason of his rapid progress, and he has not found it worth while to economise on research. Moreover, the generally high level of wealth in the United States has permitted the manufacturer to neglect the very cheap set and concentrate all his energy on the reproduction of a higher quality product. Sets such as described above range from about £25 up, a price which could not be approached unless a very large market were available. In another respect the conditions in America and England differ. Instead of the well ordered state of affairs existing in England regarding the erection of broadcast stations, there are innumerable stations in America. This necessitates the construction of highly selective receiving sets, and a very cheap set cannot be highly selective. That is the reason why four tuned circuits are used in most sets, and perhaps also why the manufacturers do not cater for the cheap product.



The last word in screening. The "First National" receiver, containing four S.G. valves. The chassis is of cold rolled steel, silver plated.

CURRENT TOPICS.

THE NEW CALL.

The expression "London Regional Station calling" seems to have been misheard in France. A Paris wireless journal states that the new 2LO comes on the air with: "London Bridge calling!"

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A SCOTTISH COINCIDENCE.

Since the Post Office direction-finding van arrived in Glasgow a fortnight ago it is reported that the number of wireless licences taken out during the period has shown an increase above the average of over a thousand.

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BEIRA TELLS THE WORLD.

The erection of a short-wave station has placed Beira (Portuguese East Africa) in touch with practically the whole world. During the past year, says *The African World*, the station has been in communication with Tokio, Cachila (Chile), Torrensville (Australia), Pasa de Toros (Uruguay), Santos (Brazil), and Karachi (India).

oooo

PORTRAIT UNVEILING BY WIRELESS.

Pressing the key of his short-wave transmitter at Little America Camp, in the Antarctic, Commander Byrd blew a motor horn and drew aside curtains covering his enlarged portrait at the recent National Radio Exposition at Los Angeles.

The pre-arranged signal from Byrd's camp was picked up by KPH, San Francisco, and relayed by wireless to KSE, Torrance, twenty miles from Los Angeles. From Torrance the impulse travelled by land line to the exposition hall, where a crowd of 10,000 watched the experiment.

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I.E.E. WIRELESS SECTION.

Captain C. E. Kennedy-Purvis, R.N., chairman of the Wireless Section of the Institution of Electrical Engineers, will give an inaugural address at a meeting of the Section on Wednesday next, November 6th, to be held at the Institution, Savoy Place, W.C.2, at 6 p.m.

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FRANCO-NORWEGIAN BROADCASTING EXCHANGE.

An exchange of broadcast programmes between Norway and France is being sought by the *Service de la Radiodiffusion Française*, which is negotiating with the Norwegian Broadcasting Company at Oslo

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for land line relays. In a few days' time it is hoped that the Oslo evening programme will be relayed to all the State transmitters in France. Later a symphony concert from Paris will be relayed to Norway.

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WIRELESS FOR JAPANESE TIME-SERVERS.

Following America's example, the Japanese prison authorities have decided that convicts shall enjoy special radio concerts. They must also listen to educational talks.

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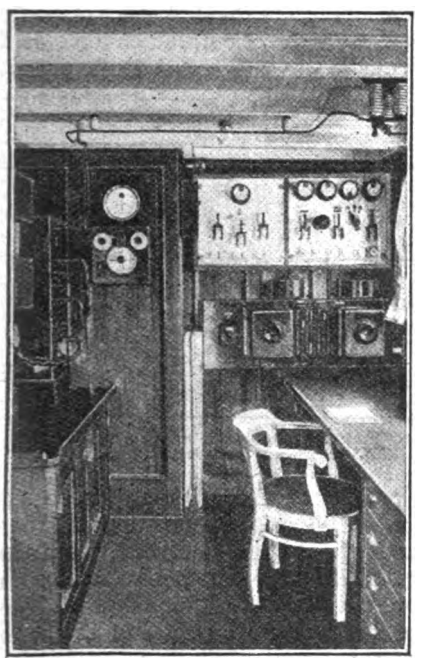
INTERMEDIATE WAVES FROM FRANCE.

Gramophone transmissions on 175 metres (coming within "intermediate" waveband of the Hague Conference) are given on Tuesdays and Fridays between 21.30 and 22.30 G.M.T. from a small experimental station at St. Quentin. The call-sign is F8GM.

oooo

A RUM-RUNNERS' WIRELESS STATION.

The discovery and seizure by the U.S. Government of an unlicensed wireless station operated by rum-runners is described by the New York correspondent of *The Times*. The capture resulted from preparations extending over six months, which culminated on October 16th in a series of police raids along a front of 100



THE PERFECT YACHT. The wireless cabin on the motor yacht "Orion," stated to be the biggest privately owned yacht in the world. Built at Kiel with a tonnage of 3,000, the "Orion" has just been delivered to her owner, Mr. Julius Forstmann, a New York millionaire.

miles from Atlantic City, New Jersey, to Sag Harbour, Long Island.

The campaign started in April last, when an inspector for the Federal Wireless Commission reported the existence somewhere near New York of an unlicensed wireless station which habitually sent out its messages in code. The messages were deciphered and the code learned, and the Treasury Department was informed of the discovery. Thereafter, every message this station sent out was recorded.

The information secured by the Treasury through these wireless messages was invaluable in its preparations for its attack on the "ring."

On the day of the raid, the police came upon the station in the Atlantic highlands, close to New York, at the very moment when the operator was sending out one of his code messages. Before he could give a warning he was thrust from his seat and a Government expert, using the same code, sent out messages which brought one of the largest of the expected rum-running ships into the reach of a Revenue cutter.

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LIFEBOAT WIRELESS.

The Plymouth lifeboat is the latest to be equipped with wireless telephony.

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INVESTIGATION INTO PATENT LAW?

The committee, which was set up under the chairmanship of the Right Hon. Sir Charles Sargant to consider whether any amendments in the Patents and Designs Acts, or any changes in Patent Office practice, were desirable, are continuing their meetings at the Board of Trade for the purpose of hearing evidence from interested persons and associations.

Those who desire to submit any suggestions, or to give evidence, are invited to communicate with the secretary, Mr. R. W. Luce, Industrial Property Department, Board of Trade, 25, Southampton Buildings, W.C.2.

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CHICAGO AS U.S. BROADCASTING CENTRE.

Complete plans for "the world's most pretentious broadcasting quarters" have been prepared by the National Broadcasting Company of America. These will be the new Chicago studios on the roof of the Merchandise Mart, in the heart of the city.

It is hoped that January 1st, 1930, will be the opening date, when six studios should be ready for use. Studio "A," it is stated, will be the largest radio theatre in the world, with standing room for more than a thousand persons. (The biggest "studio" in "Broadcasting House," Portland Place, will provide seats for this number!)

The Chicago headquarters of the N.B.C. will be larger and more imposing than those at New York, Washington, and San Francisco.

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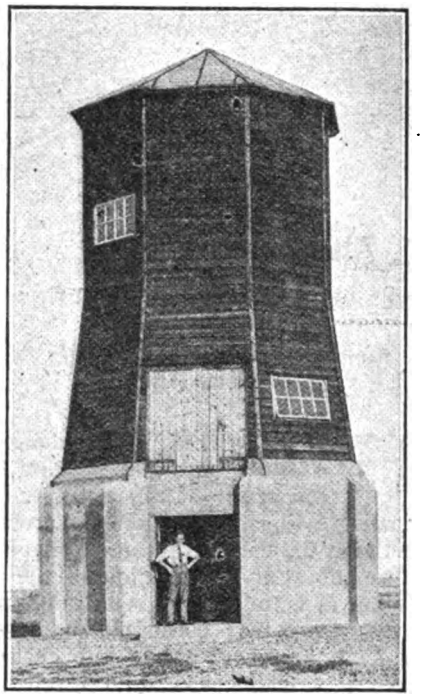
MAKING SPANISH WIRELESS HISTORY.

By the opening of a new group of beam stations at Aranjuez by the King of Spain last week, Madrid is now placed for the first time in direct wireless telegraphic communication with both North and South America. In addition, a Marconi short wave beam installation included in the equipment provides a regular commercial telephone service between Spain and the Argentine Republic.

The supply of this apparatus to Transradio Espanola is the second big order for British wireless equipment recently received from Spain, the Marconi Company having also supplied a short-wave station to the Spanish Government to establish



RADIO "LIGHTHOUSE" FOR AIRMEN. An experimental beacon at Orfordness, Suffolk, operating with a rotating frame aerial. Continuous-wave signals are transmitted for five minutes at a time, with alternate five-minute periods of silence. The apparatus, which is automatic, changes hourly to interrupted C.W.

a direct wireless service between Madrid and the Spanish colony at Fernando Po, in Equatorial Africa.

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NEW EMPIRE BROADCASTING SCHEME?

In the Editorial of Wednesday last, *The Wireless World* criticised the B.B.C.'s policy in regard to Empire broadcasting and urged the new Chief Engineer and his staff to show the same degree of enthusiasm for achieving an Empire short-wave service as, on other wavebands, has already won for British broadcasting a reputation second to none.

Subsequently a note appeared in the daily Press suggesting the strong possibility that the present Empire experimental short-wave broadcasting service from 5SW, Chelmsford, will shortly be superseded by regular Empire transmissions from a new B.B.C. short-wave station.

A statement was made to *The Wireless World* by the B.B.C. at the time of going to press to the effect that the Corporation is considering the future of short-wave broadcasting from this country and is already negotiating on the question, but that no decision has been taken to build a station at Daventry or elsewhere.

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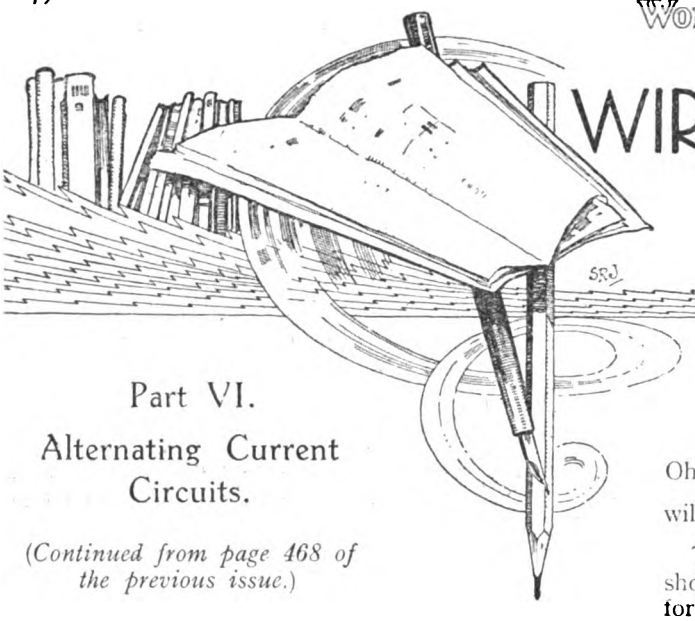

WIRELESS THEORY SIMPLIFIED

Part VI.
Alternating Current Circuits.

(*Continued from page 468 of the previous issue.*)

By S. O. PEARSON, B.Sc., A.M.I.E.E.

HAVING learned a little about inductance and its effects we are in a position to proceed with the discussion of alternating current circuits. In dealing with a steady direct current, the relationship between the current and the voltage can be determined if we know only the resistance of the circuit, by the application of Ohm's law. With alternating currents, however, the other constants, namely, inductance and capacity, must be taken into account. For the time being we shall consider one or two circuits possessing resistance and inductance both singly and together, and assume that no capacity is present.

Simple Circuit with Resistance Only.

For the moment let us consider the simplest A.C. circuit imaginable, namely, a straight piece of resistance wire connected to a source of A.C. supply, or to the terminals of an alternator as shown in Fig. 1. We can treat such a wire as a pure resistance of R ohms possessing neither inductance nor capacity, and apply Ohm's law in the ordinary way. If a sine wave of alternating voltage is applied to its ends, the current taken will be at every instant proportional to the voltage and will, therefore, also vary according to a sine law.

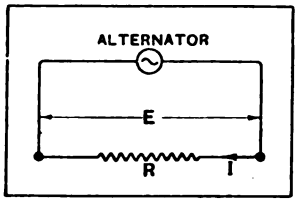

Fig. 1.—Simple A.C. circuit with resistance only.

When the voltage reaches its maximum value the current will be greatest, and when the voltage is passing through one of its zero values the current will be doing likewise. *Hence for a pure resistance the current and voltage waves are exactly in step or in phase.* These conditions are clearly shown by the curves and vector diagram of Fig. 2.

Relationship Between Current and Voltage.

Let E_m be the maximum or peak value reached by the alternating voltage every half cycle. Then by Ohm's law the maximum value attained by the current will be $I_m = \frac{E_m}{R}$ amperes.

The effective or R.M.S. value of a sine curve was shown to be 0.707 of the maximum value and, therefore, if we multiply each side of the above equation by 0.707 it will give the relationship between the R.M.S. values of the current and voltage, namely, $I = \frac{E}{R}$ amperes, where I and E are the effective values as indicated by an ammeter and voltmeter respectively.

The conclusions are then that for a simple A.C. circuit with resistance only, (*a*) Ohm's law may be applied as in the case of a direct-current circuit; and (*b*) the current and voltage waves are exactly in phase.

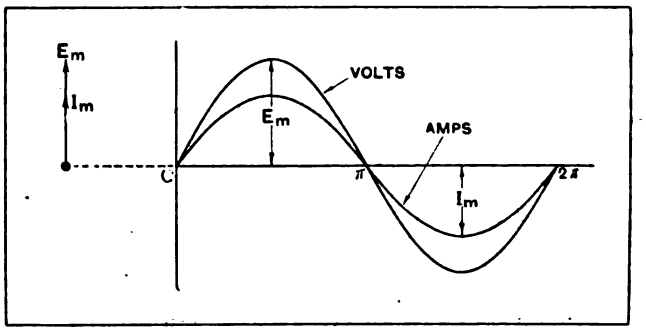

Fig. 2.—For a simple resistance the current and voltage are in phase and the corresponding vectors are parallel with each other.

Frequency plays no part whatever providing the resistance remains constant. When we come to consider high-frequency effects it will be seen that the resistance of a conductor actually increases as the frequency is raised, but for the present we shall assume that we are dealing with low-frequency currents only and that the resistance remains constant.

Power in Simple A.C. Circuit.

Since the effective value of an alternating current was defined as the value of the direct current which would have the same heating effect in the resistance, it follows that the average power expended in the resistance R is given by $P = I^2R = IR \times I$ watts. But we have just seen that $E = IR$ for a pure resistance and, therefore, the power is given by $P = E.I$ watts, just as though we were dealing with a direct-current circuit.

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Wireless Theory Simplified.—

It will be shown presently that this is not true if the circuit contains inductance—it only applies to a pure resistance.

The Effect of Inductance.

In an A.C. circuit the current is changing at all times, except during the minute fraction of a second every half-cycle when it ceases to increase and begins to fall again. In the last part it was explained how

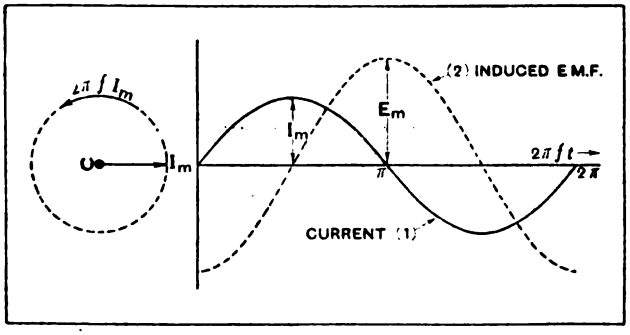

Fig. 3.—The speed of the end of the vector OI_m gives the maximum rate of change of current. The induced E.M.F. is out of step by a quarter of a cycle, with respect to the current.

the changing of a current in a circuit containing inductance caused an E.M.F. to be generated in the circuit, and it was shown that the magnitude of this induced E.M.F. was given by the product of the inductance in henrys, and the rate at which the current is changing in amperes per second.

Now suppose that we cause a sine wave of alternating current, whose maximum value is I_m amperes, to flow through a coil having an inductance of L henrys. The resulting magnetic flux linked with the coil will also vary according to the sine law, being at every instant proportional to the current producing it, and this varying magnetic flux will generate a sine wave of E.M.F. in the coil. The sine wave of current is shown by curve (1) of Fig. 3.

Our immediate task is to find out the magnitude of this induced E.M.F. and its phase relationship to the current, that is, whether it is in step with the current or not, and in the latter event, how far out of step it is. In the first place we do know that the induced E.M.F. always acts in such a direction that it tries to prevent the changing of the current (Lenz's law as explained in the previous part), and we shall make this our starting point.

Just as the current is passing through its maximum value, it is neither increasing nor decreasing—its rate of change is zero—and therefore at these instants the back E.M.F. will be zero. Thus the induced E.M.F. wave must be exactly a quarter of a cycle out of step with respect to the current wave. Now when the current is increasing from zero to the maximum positive value the induced E.M.F. will be negative, because it is opposing the growth of the current. Thus the induced E.M.F. wave will be in the position shown by the dotted curve (2) of Fig. 3. A glance at the curves will show that the current reaches its maximum positive value a quarter of a cycle *before* the induced E.M.F. wave, and therefore that the current leads the induced voltage by an angle of exactly 90 degrees.

Magnitude of the Back E.M.F.

Obviously the current is changing at its greatest rate just as it passes through its zero values, because the slope of the current curve is steepest at these points. The curves of Fig. 3 confirm that the E.M.F. is a maximum when the current is zero. Now if the maximum value of the current is I_m amperes, and its frequency f cycles per second, it can be represented by a vector whose length is I_m to some suitable scale, rotating about one end with a speed of f revolutions per second, or. $2\pi f$ radians per second (*see* Part IV, October 16th issue). The actual speed of movement of the extremity of this vector round the circle of radius I_m will be represented by a distance equal to f circumferences every second. But the circumference is 2π times the radius, and therefore, the speed of the end of the vector OI_m is $2\pi I_m \times f$, and since the vertical scale of the current curve is in amperes, this speed will represent amperes per second. This value then gives us the maximum rate of change of current, being $2\pi f I_m$ amperes per second.

The induced E.M.F. is equal to the product of the rate of change of current and the inductance (explained in Part V). Hence the induced or back E.M.F. will have a maximum value of $E_m = 2\pi f I_m \times L$ volts, where L is in henrys; or $E_m = 2\pi f L \times I_m$ volts.

Coil with Inductance Only.

We shall first assume that the coil of inductance L henrys under consideration has no resistance whatever. Hence to drive a current through it there is only the back E.M.F. of self-induction to be overcome by the

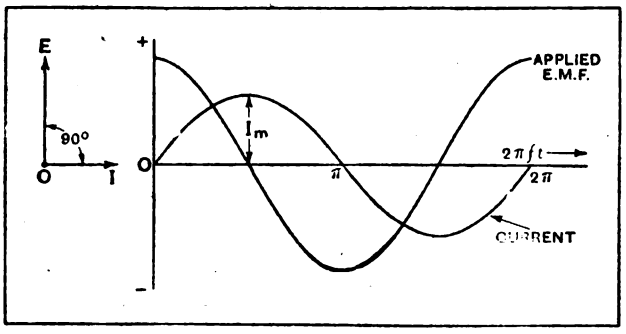

Fig. 4.—For a pure inductance the current lags by 90 degrees behind the supply voltage.

supply voltage, and therefore the maximum value of the applied E.M.F. will also be given by $E_m = 2\pi f L \times I_m$.

The applied E.M.F. or supply voltage must exactly neutralise the induced E.M.F. at every instant, and is, therefore, represented by another sine wave in exact opposition to the wave of induced E.M.F. The phase relationship between the applied voltage and the current is shown by the curves of Fig. 4.

Note that the current curve reaches its maximum value a quarter of a cycle later than the applied E.M.F. and therefore *for a circuit possessing inductance only, the current lags behind the supply voltage by exactly*

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Wireless Theory Simplified.—

90 degrees. Also note that the vectors on the left of Fig. 4, representing the current and voltage, are drawn at right angles to each other. In future we shall dispense with curves as far as possible and use the vectors only.

Reactance.

So far we have found the relationship between the maximum values or amplitudes only of the current and

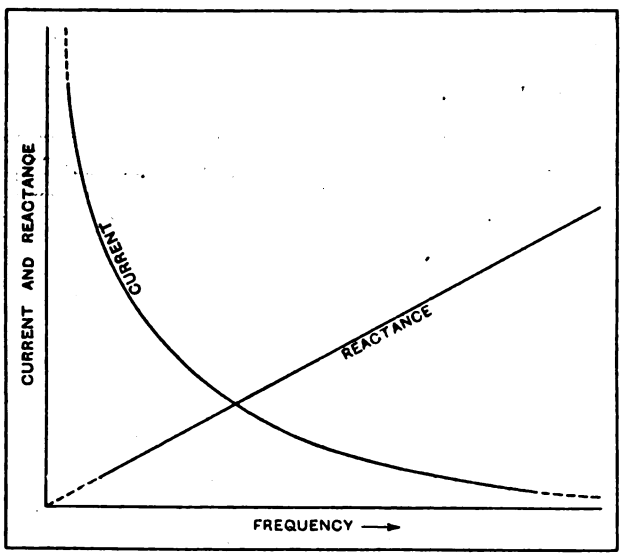

Fig. 5.—Curves showing how reactance and current vary with frequency for a coil having inductance only.

voltage for a pure inductance. If we multiply each side of the last equation by 0.707 we obtain the R.M.S. value of the voltage, viz.: $E = 0.707E_m = 2\pi fL \times 0.707.I_m$; or $E = 2\pi fL \times I$ volts, where $I = 0.707.I_m$ is the effective value of the current. This result may be rewritten thus $I = \frac{E}{2\pi fL}$ amps.

We have here an extremely important result. It is a relationship of the same kind as Ohm's law, the only difference being that in place of the resistance R we have the quantity $2\pi fL$. This is called the *reactance* of the coil and is expressed in ohms. It is usually denoted by X and so for a coil with inductance only the current is given by $I = \frac{E}{X}$ amperes, and lags behind the voltage by 90 degrees. Expressed in words the inductive reactance of a circuit may be defined as the opposition set up to the passage of an alternating current by the induced E.M.F. of self-induction. This definition is of fundamental importance.

It should be noted that the reactance of the coil is directly proportional to the frequency of the current, so that at very high frequencies such as those met with in radio work even a coil of a few turns and low inductance will have a comparatively high reactance. Suppose that a voltage of constant R.M.S. value is applied to a coil of L henrys inductance and that the frequency is gradually increased from a very low value upwards. The reactance will increase in direct proportion, and if plotted as a graph against the frequency will give a straight line passing upwards from the origin O as shown by the curve of Fig. 5. The current, being inversely proportional to the reactance, will vary in inverse proportion to the frequency, and the curve showing their relationship will be of the form indicated in the figure, the curve being a hyperbola.

Numerical Example.

Consider a coil of negligibly small resistance having a self-inductance of 20 henrys. We shall calculate what current will be passed if 10 volts (R.M.S. value) are applied to the terminals when the frequency is (a) 50 cycles per second and (b) 2,000 cycles per second. At 50 cycles the reactance will be $X = 2\pi fL = 2\pi \times 50 \times 20 =$ 6,280 ohms, and at 2,000 cycles X works out to 251,200 ohms. The currents will thus be (a) $I = \frac{10}{6,280} = 0.00159$ amp. or 1.59 milliamps. and (b) $I = \frac{10}{251,200} = 0.0000398$ amp. or 0.0398 milliamp. Figures of this order are encountered in connection with low-frequency chokes in receiving circuits.

Choking Coils.

The property of an inductance coil of opposing the passage of an alternating current through it is used to a very large extent. A coil without any resistance whatever, if such were possible, would allow a direct current to pass through it unimpeded, although choking back alternating currents to an extent depending on the frequency. An actual coil with low resistance has approximately the same effect. Such a coil is usually referred to as a *choking coil* or *choke*. To produce a desired choking effect or reactance, the value of the inductance must be chosen to suit the frequency of the current—high inductance is required where the frequency is low and vice versa. To obtain a high reactance at low frequencies the coil is wound with many turns on a closed iron core and is referred to as a "low-frequency choke" when used in a wireless circuit.

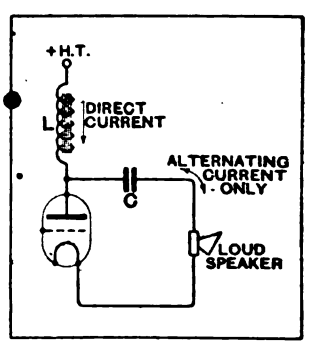

Fig. 6.—Normal output circuit for the last stage of an amplifier. By the action of the choke L the alternating currents in the plate circuit are forced to pass through the loud speaker.

In a receiving circuit choking coils are used in various places where it is required to pass a direct current freely and to prevent as far as possible the passage of alternating current, the object being to filter out the alternating current from the direct. A case in point is the output filter circuit between the last valve of an amplifier and the loud speaker. It will be shown later that a condenser has the reverse effect—allowing alternating currents to pass whilst totally preventing the passage of any direct current.

(To be continued.)

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Broadcast Brevities

By Our Special Correspondent.

The Twin Regional Station.—What of the Prague Plan?—Missing Bass.

Listeners and Brookman's Park.

Optimistic though the Technical Correspondence people at Savoy Hill undoubtedly are, they fully expected a storm to break over their heads on the morning after the change-over from Oxford Street to Brookman's Park. At the time of writing there has been no storm, but only sunshine and shower as represented by a nearly equal proportion of favourable to unfavourable reports.

As might be expected, crystal users are loudest in their disapproval of the new order. Valve set owners, even if they suffer some inconvenience in areas near the new transmitter, have a technical grasp of the situation which the average crystal user seems unable to obtain.

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The Real Test to Come.

The mass of reports from all districts within the service area of Brookman's Park confirm predictions in a remarkable manner. Listeners far afield who obtained only an indifferent service from Oxford Street are unanimous in praising the new station, while those who have enjoyed the London transmissions without disturbance are inclined to criticise the quality of signals and the comparative coarseness of tuning.

But the real test has yet to come. Tweedledum and Tweedledee must perform simultaneously before we can justly assess the value of either.

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Is Tweedledee Performing?

A rumour has reached me that the second transmitter has already been in action.

When I recall the vision of that noble transmitter standing idle, merely awaiting the manipulation of a few switches to set it in operation, I find myself wondering whether B.B.C. engineers have superhuman powers of restraint. It might be worth while to test this theory by listening after midnight in the region of 262 metres.

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Another Mouth to Feed.

I can discover no anxiety among the members of the Programme Department regarding the additional work lying in wait for them when the second station begins regular transmissions.

"There's plenty of time yet," was the airy reply to my query. "Tweedledee must undergo its tests first; the question of a programme won't crop up until January."

During the testing period, timed to begin in mid-December, the second station will relay the programme of 5GB.

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The Passing of the Prague Plan.

"The Prague Plan is already dead," says a friend of mine who, with a hyper-selective super-sensitive receiver, has spent the last fortnight in "touring" Europe. "Heterodyning on the British stations is bad enough," he asserts, "but on the Continent it is infinitely worse, and the U.I.D.R. at Brussels seems unable to control the pandemonium."

He considers that the present separation of 9 kilocycles between stations is useless in view of the universal tendency towards higher power, and he pleads for a separation of 15 kilocycles as the irreducible minimum.

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Mañana.

An instance of the way in which the instructions of the Brussels frequency measuring centre are ignored occurred last week when, at the request of the B.B.C., a message was sent from Brussels to the San Sebastian broadcasting authorities asking them to keep off Glasgow's frequency of 752 k.c. "Mañana," said the Spaniards, and nothing was done. The British Post Office is now approaching the Spanish Government on the question so possibly Glasgow will soon be relieved of San Sebastian's whistle, but at whose expense? No doubt San Sebastian had splendid reasons for quitting its allotted frequency. Every station has.

The Missing Bass.

There was a state of ferment at Savoy Hill a few days ago when a listener whose opinion carries weight telephoned to say that the bass notes were not coming through. A rushing hither and thither, with hurried consultations in the control room, revealed nothing amiss on the technical side. Then somebody smitten with a brain-wave dashed to the studio in which a well-known "Auntie" was providing a pianoforte interlude.

"Bass notes not coming through?" said the pianist. "No, of course not. That last piece was for the right hand only!"

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For Scots in Exile.

St. Andrew's Night is an even greater occasion for the exiled Scot than for the Scot who still lives on the right side of the border. With this thought definitely in mind, a St. Andrew's Night programme will be relayed on November 30th from Glasgow to 2LO, 5XX and other stations.

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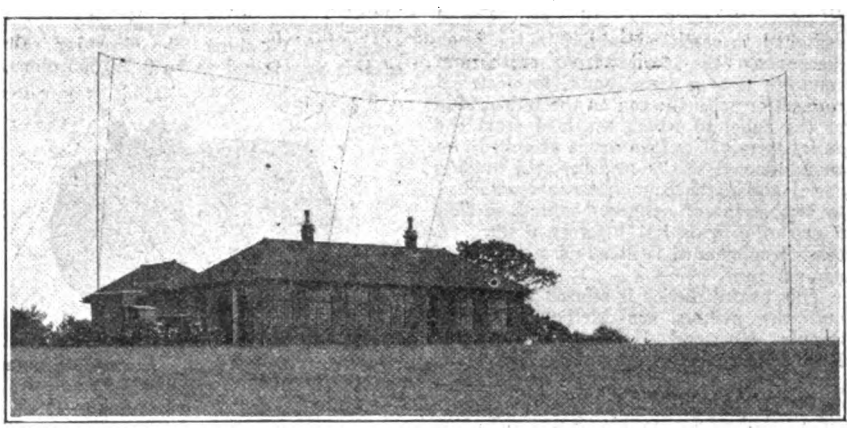
The Week in Parliament.

Women M.P.s are to describe "The Week in Parliament," in a series of weekly broadcasts, starting on November 6th. Mrs. M. A. Hamilton, the member for Blackburn, launches the new feature, and will be followed a week later by the Duchess of Atholl. These broadcasts will run throughout the session.



THE B.B.C.'S RECEIVING STATION. The newly completed listening post at Tatsfield, Surrey, where British and European wavelengths are checked. The masts are 60 feet high and the site is 900 feet above sea level. During the winter the station may be used for relays from America.

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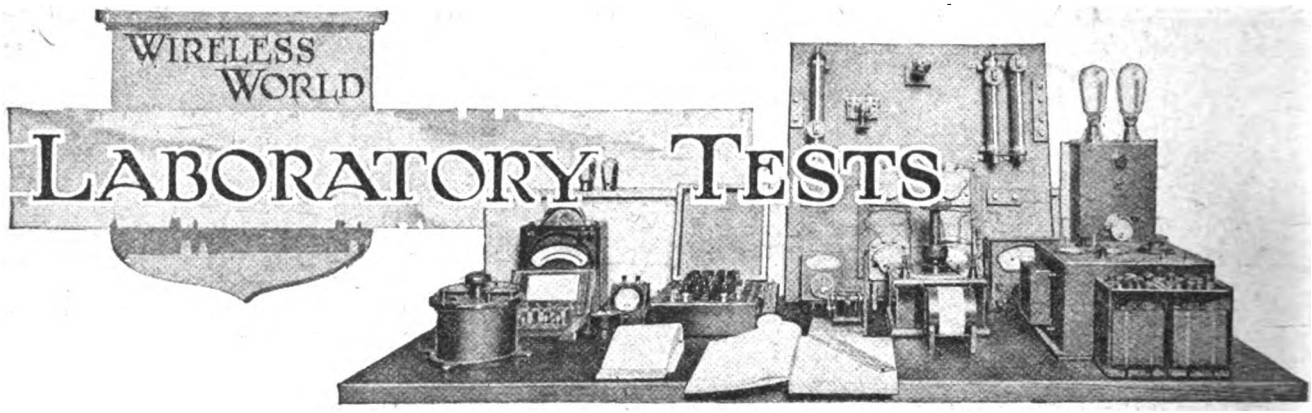
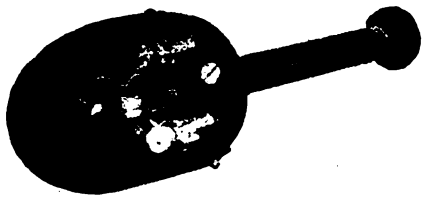


A Review of Manufacturers' Recent Products.

"MELBOURNE" SAFETY LEAD-IN.

Many ingenious devices have appeared to ensure complete isolation of the wireless set from the outside aerial, thus safeguarding the apparatus against damage during electrical storms. To these must be added the "Melbourne" combined lightning arrester, earthing switch and lead-in tube.



"Melbourne" lead-in tube with outside earthing switch controlled from inside the building.

It consists of a polished ebonite tube terminating, at the outdoor end, in a circular disc which supports aerial and earth terminals, earthing switch and a safety gap. At the other end is a large diameter knob for controlling the switch and a contact for the lead to the set. When the knob is pulled out, the aerial is disconnected from the receiver and switched to earth. Pushing in the knob disconnects the aerial from earth and connects it to a metal band, in electrical connection with the tag on the indoor side of the tube, to which the lead from the aerial terminal on the set is attached. As an additional safety measure, the outside aerial and earth connections are attached to two strips of copper mounted so that a gap of $\frac{1}{32}$in. is left between them. A semi-circular cowl is fitted as a protection against rain

This useful device is offered at 3s. 6d., and the makers are Melbourne Radio Supply, Norwood Buildings, Hatherley Road, Walthamstow, London, E.17.

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"PILOT" RESISTANCES.

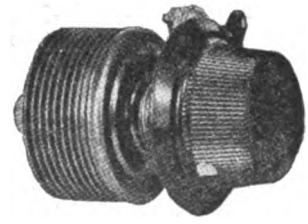
"Pilot" components, which are manufactured in America by the Pilot Radio and Tube Corporation, are now available in this country, the sole concession for their distribution having been acquired by Messrs. T. A. Rowley, Ltd., 59, Skinner Lane, Dean Street, Birmingham. The samples sent in for test comprise a "Pilot" Resistograd and a Volumgrad.

The first mentioned is a variable high resistance of the compression type, rated to be adjustable to any resistance value between 40 ohms and 10 megohms. This range is covered by four complete revolutions of the knob.

A curve is supplied with each component, showing the change in resistance with rotation of the knob. Measurements gave the minimum and maximum values as 20 ohms and 20 megohms respectively.

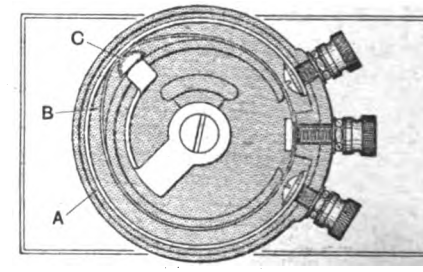
The resistance element is enclosed in a strong metal case 1½in. in diameter and 1½in. deep over the back terminal. The outside of the container is provided with fins, presumably to radiate rapidly any heat that may be generated. It can be used, therefore, in circuits passing current, such as voltage control in battery eliminators, or as a volume control across the primary of the L.F. transformer. The price is 4s. 3d.

The Volumgrad is a high-resistance potentiometer, and is made in four values—0-50,000 ohms, 0-100,000 ohms, 0-200,000 ohms, and 0-500,000 ohms. The sample supplied was the last-mentioned type—viz., 0-500,000 ohms. The measured value of this was found to be 0-550,000 ohms.



"Pilot" Resistograd. A variable high resistance for power use.

The device consists of a moulded bakelite case 2in. in diameter. The resistance element, which is a strip of non-hygroscopic material coated with a special preparation, is attached to the side of the hollow case, and a connection is made at both ends by means of small terminals. The variable contact is made through the medium of a flexible phosphor-bronze spring, of slightly smaller diameter than the resistance element. An insulated button, attached to the rotating arm, presses a section of this spring onto the surface of the resistance. Since the action is more in the nature of a rolling movement than a rubbing contact, wear on the element itself is reduced to a minimum. A single-hole fixing bush, completely insulated, is fitted.



Track wear is obviated in the "Pilot" Volumgrad by rolling a spring onto the resistance element. "A" is the resistance, "B" the spring and "C" the insulated button attached to the operating arm.

This component should not be used in circuits passing any appreciable current. It will find favour as a potentiometer volume control in grid circuits, or across the terminals of a gramophone pick-up. The price of all models is 6s. 6d. each.

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HAW'S MAINS EQUIPMENT.

A wide range of A.C. mains transformers, smoothing chokes, and all parts necessary for the construction of H.T. battery eliminators and L.T. trickle chargers, have been introduced recently by Messrs. Haw & Co., Ltd., 20, Cheapside, London, E.C.2. In addition, factory-made models embodying similar components are available for those not

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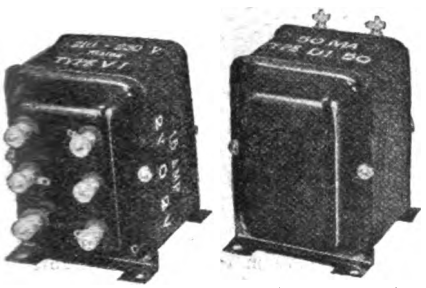
possessing the facilities for building these at home.

The complete units and parts, which are of foreign make, are being marketed at attractive prices. The A.C. eliminator,

Haw's half-wave rectifier H.T. battery eliminator, Model N.G. A Philips 373 valve is recommended.

Model N.G., designed for use on 200-230 volts, 50 cycle mains, is fitted with a half-wave rectifier rated to give 20 mA., and should be suitable for most 3- and 4-valve sets fitted with a small power valve. One variable tapping, 0-100 volts, and one fixed 150-volt output are provided. Complete with valve this costs 68s.

The Model VI power transformer, for use on 210-230 volts, 50 cycle mains, is designed to deliver 50 mA. at 180 volts after rectification. This carries two secondary



Haw's mains transformer, Type VI, and large smoothing choke, D.150, rated to carry 50 mA.

windings, 200+200 volts for H.T., and 2+2 volts, at 1.5 amps. for the filament of the valve rectifier. All terminals are clearly marked, and the price is 14s.

Smoothing chokes, ranging from 10 henrys to 40 henrys are now listed. The D.150, which is the model illustrated, has a rated inductance of 40 henrys, and is stated to carry 50 mA. The price is 13s. 9d. The small model, D.30, of 10 henrys, costs 5s. 6d.

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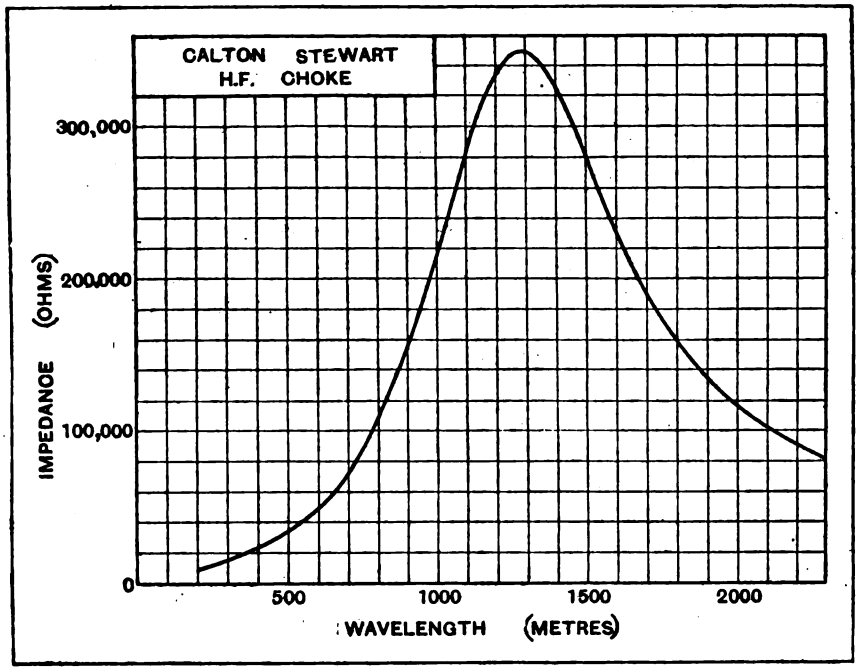
CALTON STEWART H.F. CHOKE.

The construction of this choke enables it to be mounted in spring clips on the baseboard or suspended in the wiring

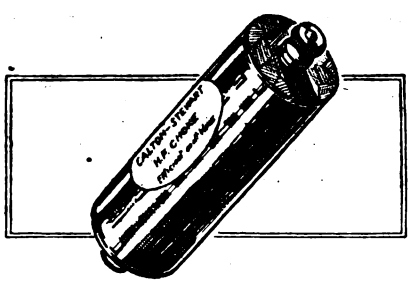


Impedance curve of Calton Stewart H.F. choke; external capacity 8 micro-mfd.

of the receiver. The choke is light in weight, and is eminently suitable for the latter method of wiring, which has many points in its favour.

The windings are supported on skeleton paxolin former, and are enclosed in a celluloid tube 2½in. long and 1in. in diameter. Terminals are carried in the moulded ebonite end plates as shown in the illustration.

Having regard to the low price of 2s., the performance is remarkably good. The curve is free from subsidiary resonances, and under working conditions the choke should be safe as regards self-oscillation up to the wavelength of 5XX. Under the conditions of the test with a small external capacity of 8 micro-mfds., the resonance is at 1,300 metres, at which point the impedance reaches 348,000 ohms. Over the 200-500-metre band the impedance rises from 9,640 to 30,600



Calton Stewart H.F. choke; D.C. resistance 700 ohms.

metres, while on ultra short wavelengths the choking effect is still adequate.

Supplies are available from Messrs. J. McMillan and Co., 1, Hunter Square, Edinburgh.

CATALOGUES RECEIVED.

The Benjamin Electric, Ltd., Brantwood Works, Tottenham, London, N.17. —Illustrated broadsheet dealing with seven components introduced recently.

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Radio Intruments, Ltd., 12, Hyde Street, New Oxford Street, London, W.C.1.—Descriptive folder of the R.I. Screened-Grid All-Electric 3-valve receiver.

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Messrs. A. F. Bulgin and Co., 9-11, Cursitor Street, Chancery Lane, London, E.C.4.—A 55-page catalogue of Bulgin products. Profusely illustrated and devoting 20 pages to a technical description of the method of using some of the principal components now listed.

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Messrs. Garnet, Whiteley and Co., Ltd., Lotus Works, Mill Lane, Liverpool. —A 20-page catalogue illustrating their new season's components. Also a 12-page descriptive booklet of "Lotus" receivers.

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Messrs. J. J. Eastick and Sons, Eelex House, 118, Bunhill Row, London, E.C.1. —Illustrated catalogue of proprietary radio equipment handled by this firm.

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The Portable Electric Light Co., Ltd., 120, Shaftesbury Avenue, London, W.1.—Illustrated price list of Ever-Ready batteries for wireless and portable hand lamp uses.

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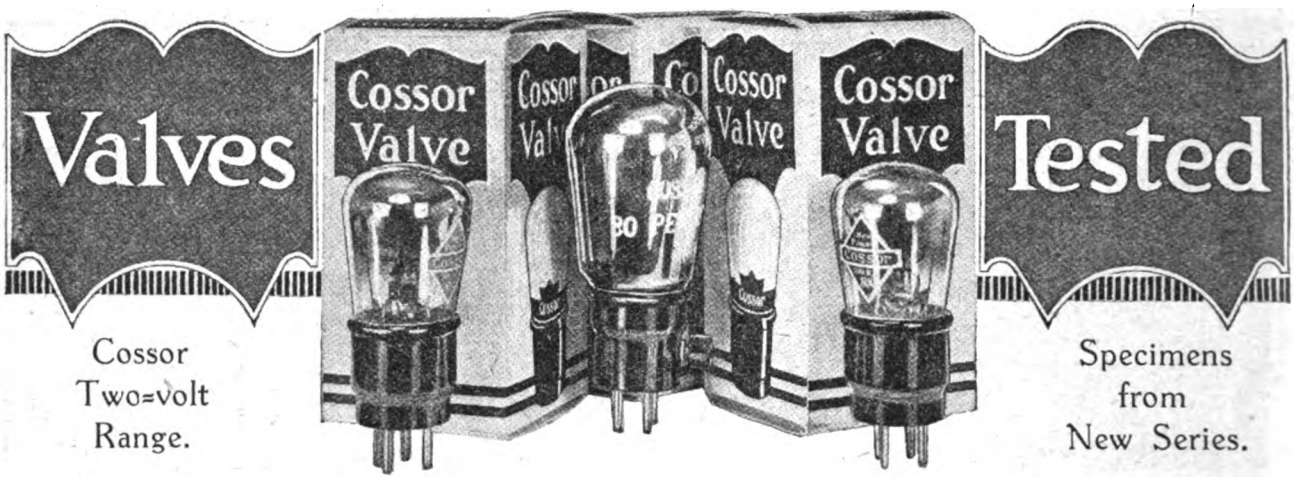
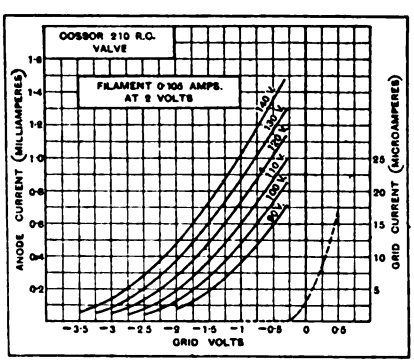


THE complete range of two-volt valves in the Cossor series comprise seven types in all, but owing to certain specimens not being available we are restricted in this review to a consideration of the merits of five. Those to be dealt with are the 210 R.C., 210 H.F., 210 L.F., 220 P., and the 230 P.T. The first four are triodes, and the last-mentioned a pentode. The complete range includes, in addition, a super-power three-electrode output valve, the 230 X.P., and a screen-grid type, the 220 S.G. It is hoped that an opportunity may arise to deal with these two valves later.

210 R.C.

This is a high-impedance valve with a nominal A.C. resistance of 60,000 ohms and an amplification



Average values under working conditions: A.C. resistance, 67,000 ohms; amplification factor, 40; mutual conductance, 0.6 mA/v.

factor of 40. The particular function allotted to a valve in this class hitherto was that of an amplifier followed by resistance-capacity coupling. To-day this practice is not usually adopted, as it has the disadvantage that the higher musical frequencies are not amplified in the same proportion as the very low notes, so that its usefulness is generally restricted to that of an anode bend detector. However, as this must be used in conjunction with a high value of anode resistance, some loss in the amplification of the higher musical notes will be inevitable. Where superlative quality of reproduction is not of paramount importance, but high sensitivity and selectivity is the first consideration, this valve will find a useful application.

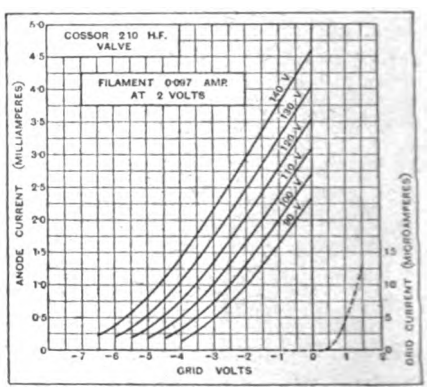
As will be seen from the table below, the measured characteristics agreed sensibly with the makers' figures.

It was noticed that grid current commenced to flow when the grid was given a negative bias of 0.3 of a volt, so that it would be advisable to apply the maximum permissible voltage to the anode, thereby enabling a negative bias of such order to be used that the operating signal does not override the permissible peak voltage that can be applied to the grid.

For dealing with relatively large inputs the suggested working conditions are 120 anode volts, and −3 volts grid bias. Small inputs can be dealt with satisfactorily by biasing the grid to −1.5 volts only. Of course the anode voltage should be reduced accordingly.

210 H.F.

As its description implies, this valve is intended for use as an H.F. amplifier, but as it is a three-electrode type a neutralised circuit must



Average values under working conditions: A.C. resistance, 26,500 ohms; amplification factor, 20; mutual conductance, 0.75 mA/v.

be employed to obtain worth-while results. Since this type of H.F. circuit is a relic of the past, the present-day function of the 210 H.F. valve is either that of a leaky grid detector or of an L.F. amplifier between the detector and output stages. When a

Characteristics at 100 Volts H.T. and Zero Grid Bias.

210 R.C.	A.C. Resistance.	Amplification factor.	Mutual conductance.
Makers' Rating	60,000 ohms	40	0.66 mA v.
Specimen I	66,500 „	37	0.56 „
Specimen II	67,000 „	39	0.58 „

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Valves Tested.—

low-frequency transformer follows this valve, preference should be given to one which possesses a high inductive primary winding, as the A.C. resistance of the valve is of the order of 20,000 ohms.

fier. Its rated characteristics are: A.C. resistance, 12,000 ohms; amplification factor, 10; and mutual conductance 0.83 mA. per volt. Transformer coupling can be used, therefore, provided the component chosen is capable of carrying the anode current, showing that the vacuum in these samples is dead hard.

The three types dealt with so far all require 0.1 of an ampere at 2 volts for the filament.

Characteristics at 100 Volts H.T. and Zero Grid Bias.

210 H.F.	A.C. Resistance.	Amplification factor.	Mutual conductance.
Makers' Rating	20,000 ohms	20	1.0 mA/v.
Specimen I	25,000 ,,	20	0.8 ,,

Owing to the improved efficiency of modern valves, it is usually permissible to employ choke-capacity coupling between the penultimate L.F. amplifier and the output stage. This possesses certain advantages, particularly as regards initial cost. A choke of not less than 100 henrys is recommended.

One specimen only of this type was suitable for test. The other showed a trace of reversed grid current which was attributed to a slight softening of the vacuum. Grid current started at zero grid volts in the specimen tested, so that with a working anode voltage of 120 a maximum grid swing of 6 volts, peak value, can be handled. The normal anode current with the above stated H.T. and −3 volts grid bias will be about 1.4 mA.

210 L.F.

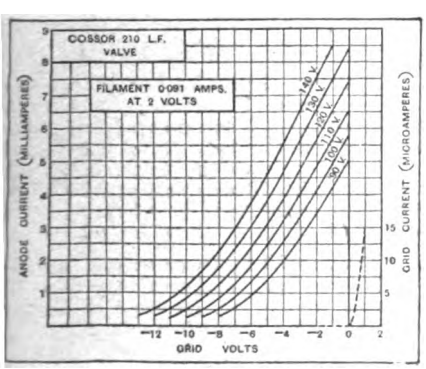
This is essentially a low-frequency amplifying valve, and its characteristics suggest that its most useful function will be in the penultimate position in a two or more stage amplifier. Its rated characteristics are: A.C. resistance, 12,000 ohms; amplification factor, 10; and mutual conductance 0.83 mA. per volt. Transformer coupling can be used, therefore, provided the component chosen is capable of carrying the anode current without leading to saturation of the iron circuit. Average values of anode current with various anode voltages are given below.

H.T.	G.B.	Anode current.
110	−4.5	2.8 mA.
120	−4.5	3.5 ,,
130	−6	3.05 ,,
140	−6	3.75 ,,

Grid bias values are given to the nearest 1.5 volts, since without the use of a potentiometer the grid bias cannot be varied in smaller steps than this.

Should it be desired to use one of the many types of L.F. transformers wound on special high-permeability iron, which limits the primary current to one or two milliamps, the parallel feed arrangement using an anode resistance and large feed condenser may be used. An anode resistance of about 30,000 ohms would be suitable, and a 1 mfd. condenser is recommended. This circuit deflects the steady D.C. current through the resistance and allows the A.C. component only to pass to the transformer.

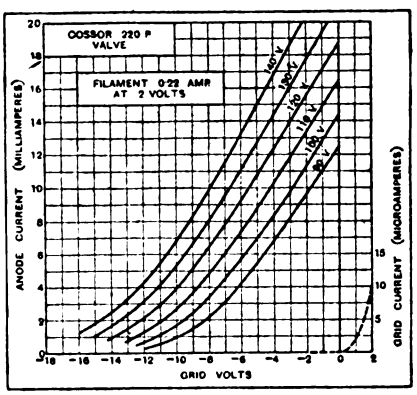
Two samples of this type were tested and the measured characteristics were found to agree fairly closely with the makers' figures. Grid current commenced at zero grid bias. There was no trace of reversed grid



Average values under working conditions: A.C. resistance, 16,000 ohms; amplification factor, 11.0; mutual conductance, 0.7 mA/v.

220P.

This is a power-amplifying valve, and will be used as a terminal valve in a receiver, or amplifier, designed for loud speaker reproduction. It cannot be included in the "super" class, but will be suitable for operating reasonably sensitive loud speakers at sufficient volume for rooms of average size. It should appeal to those listeners restricted to the use of dry batteries for the H.T. supply, as the anode current is comparatively low for a power output valve. The demand made on the battery at various anode potentials is given in the following table:—



Average values under working conditions: A.C. resistance, 5,400 ohms; amplification factor, 8.5; mutual conductance, 1.6 mA/v.

H.T.	G.B.	Anode current.
110	−7.5	5.5 mA.
120	−7.5	7.1 ,,
130	−9	6.7 ,,
140	−9	8.4 ,,

Suggested grid bias values are shown to the nearest 1.5 volt for the reason mentioned earlier.

The makers give the mutual con-

Characteristics at 100 Volts H.T. and Zero Grid Bias.

210 L.F.	A.C. Resistance.	Amplification factor.	Mutual conductance.
Makers' Rating	12,000 ohms	10	0.83 mA/v.
Specimen I	12,500 ,,	10.5	0.84 ,,
Specimen II	16,000 ,,	11.0	0.7 ,,

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Valves Tested.—

ductance of the 220 P. as being 2mA. per volt, but this figure was not quite attained with the two specimens tested. With one, a mutual conductance of 1.6 was attained, and with the other 1.87 mA. per volt. How the measured characteristics compare with the makers' rating can be seen best from the following table:—

Characteristics at 100 Volts H.T. and Zero Grid Bias.

220 P.	A.C. Resistance.	Amplification factor.	Mutual conductance.
Makers' Rating	4,000 ohms	8	2.0 mA/v.
Specimen I	4,880 ,,	7.7	1.6 ,,
Specimen II	4,650 ,,	8.7	1.87 ,,

Grid current started to flow at zero grid volts, and both specimens were found to be satisfactorily evacuated, as there was not the slightest trace of reversed grid current.

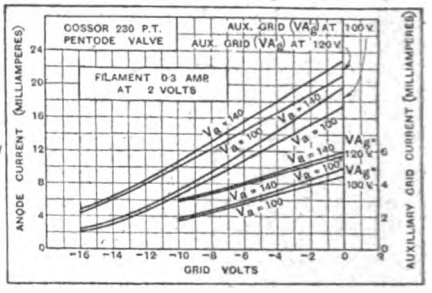
230 P.T.

The 230 P.T. is a five-electrode, or pentode, valve, and is, of course, a power amplifier. Pentodes will not accept, in general, a large grid input, so for this reason their usefulness is restricted to sets having but one low-frequency amplifying stage. As has been shown in a recent article, the characteristics of these particular valves vary between wide limits with change in auxiliary-grid and working-grid voltages, so that unless the conditions under which the makers measured the characteristics of the valve are known, comparison between figures obtained under different conditions would be misleading. This information is not available.

Our measurements were made under two conditions: first, average values between 100 and 140 volts on the anode with a fixed auxiliary grid potential of 120 volts and zero working grid bias. The second set of measurements were made with between 120 and 140 anode volts and with the auxiliary grid at the same potential. The working grid was biased to -7.5 volts.

The average characteristics from the first set of readings were: A.C. resistance, 20,000 ohms; amplification factor, 30.8; and mutual conductance, 1.54 mA. per volt. In the second case the average A.C. resistance was found to be 40,000 ohms; amplification factor, 50; and mutual conductance 1.25 mA. per volt. The makers' rating is 20,000 ohms, 40 and 2 respectively.

When choosing an H.T. battery, or supply unit, for these valves, consideration has to be given to the current flowing in the auxiliary grid circuit. To facilitate this, the curves shown are the anode-current-grid-volt curves, together with auxiliary-grid-current-grid-volt curves. The total current can be found readily at any grid bias values.



Average values under working conditions: A.C. resistance, 40,000 ohms; amplification factor, 50; mutual conductance, 1.25 mA/v.

The total current demands are rather heavy for most dry-cell type batteries, and where mains are available an H.T. supply unit would be preferable. Otherwise an accumulator H.T. battery would be, perhaps, the most economical source of H.T. supply.

Anode volts.	Auxiliary grid volts.	G.B.	Anode current.	Auxiliary grid current.	Total (mA).
100	100	-6	10.8 mA.	2.8 mA.	13.6
140	100	-6	11.8 ,,	3 ,,	14.8
100	120	-7.5	12.7 ,,	3.5 ,,	16.2
140	120	-7.5	13.7 ,,	3.7 ,,	17.4

BOOK REVIEW.

Speech and Hearing.

By H Fletcher. (Macmillan and Co., Ltd. 1929. 20s.)

The recent work on speech and hearing from the point of view of telephonic communication is ably summarised in this book.

It is surprising to learn that, while most of the energy of speech sounds is carried by frequencies below 500 c.p.s., the intelligibility is only reduced three per cent. when these frequencies are removed by a filter. The speech power emitted during average conversation is about ten microwatts, so that it would require a million people talking simultaneously to light a ten-watt lamp. Very loud speech corresponds to 1,000 microwatts, and 0.001 microwatts is the power for a soft whisper.

In the analysis of musical sounds we find that a piano emits bass notes almost entirely on harmonics, and that with the 'cello organ pipe the 3rd harmonic has about five times the amplitude of the fundamental.

The work on noise is of great interest. In perfectly silent surroundings conversation is possible over a range of 1,000ft., in a busy office over 30ft., in a boiler factory over ½in.

The masking of one tone by another shows that intense sound of low pitch can, by generating harmonics in the ear, obliterate the power of hearing all other sounds of higher pitch, but a high-pitched sound does not obliterate sound of lower pitch.

The book is packed with quantitative results about all phases of sound production and reception, and shows clearly what defects are permissible in telephone or wireless systems without undue depreciation of quality. R. T. B.

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BOOKS RECEIVED.

A.B.C. of Television or Seeing by Radio. By R. F. Yates. The theory, construction, and operation of telephotographic and television transmitters and receivers, explained in simple language. Pp. 210, with 78 diagrams and 20 illustrations. Published by Chapman and Hall, Ltd., London. Price 10s. 6d. net.

A Course-shift Indicator for the Double-modulation Type Radiobeacon. By H. Diamond and F. W. Dunmore. (Bureau of Standards, Research Paper No. 77.) A short description of the indicator used at beacon stations in U.S.A. Pp. 10, with six diagrams and illustrations. Published by the Department of Commerce, Washington. D.C. Price 5 cents.

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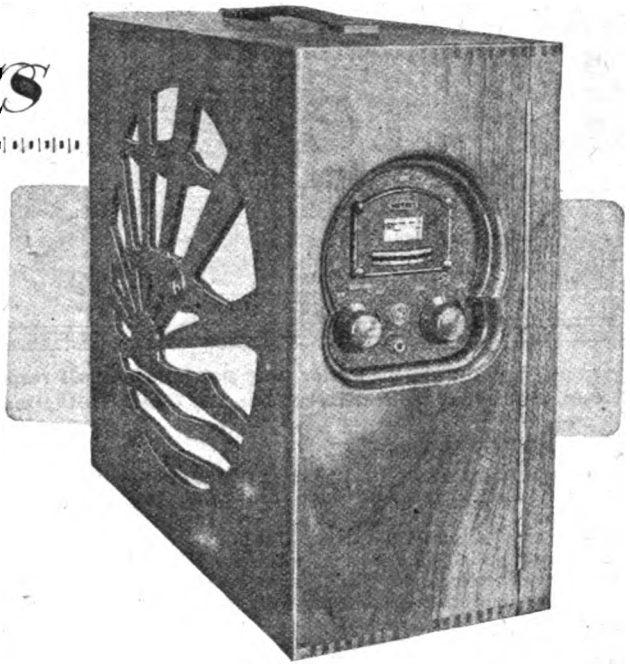
Broadcast Receivers

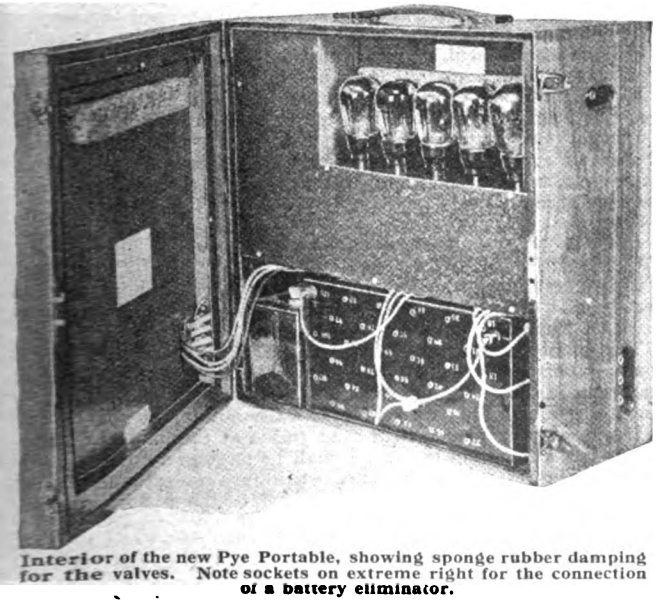
The 1930 PYE PORTABLE

Aperiodic H.F. Coupling Retained: Many Detail Refinements.



THE two aperiodic H.F. stages in the Pye Portable, using three-electrode valves, have given such satisfactory results in the past that it has been decided to retain this form of coupling in the 1930 model. Although the circuit principle and the general interior appearance of the set remains unchanged, the removal of the inside cover plate reveals that the circuit has been completely redesigned in detail. Instead of the rotating reaction coil and damping ring of last year there is a differential reaction condenser and regeneration is now confined to the detector stage. This has resulted in an improvement in selectivity on long waves.

Another important modification is the provision of sockets at the back of the set for the attachment of an external battery eliminator for H.T. supply. There are three sockets coloured to correspond with the H.T. wander plugs, which are plugged into the sockets inside the set after removing the battery. Decoupling resistances are incorporated in both positive leads and in other branches of the H.T. circuit, so there should be no trouble due to back coupling.



Interior of the new Pye Portable, showing sponge rubber damping for the valves. Note sockets on extreme right for the connection of a battery eliminator.

The control panel has been completely redesigned and is extremely pleasing to the eye. The tuning condenser is now mounted with the spindle vertical and the original bevelled dial has been replaced by a slow-motion edgewise drum dial. The scale is calibrated in metres on both wave bands and is framed in a handsome moulded escutcheon plate provided with a celluloid window and hair line. The reaction control is now placed in an accessible position below the main tuning dial in line with the wave range switch.

One of the first questions to be asked about a receiver to-day is the degree of selectivity to be expected and the manner in which it will react to the new Regional stations. Tests were made with the new Pye in central London during transmissions from Brookman's Park, and the tuning control was set first to the wavelength of 5GB and then at 261 metres—the approximate wavelength of the alternative programme transmitter at Brookman's Park. At both these settings the 356 metre transmission was still just audible even with reaction critically adjusted. The volume, however, would be insufficient to cause interference during periods of modulation and would only be heard during intervals in the programme being received.

The long wave selectivity has been much improved and there is little difficulty now in separating Radio Paris, Königswusterhausen, and Daventry 5XX.

The range and quality of reproduction are quite up to the standard of the earlier model. There is evidence that the set is sufficiently sensitive to overload the P.215 valve in the last stage, and it might be a good plan to invest in a P.240 for use with an H.T. eliminator. The P.215 would then be kept in reserve for outdoor use with the dry cell H.T.

An A.C. battery eliminator, specially designed for the Pye Portable, is available, and costs £5, while the price of the set itself is £23 10s.

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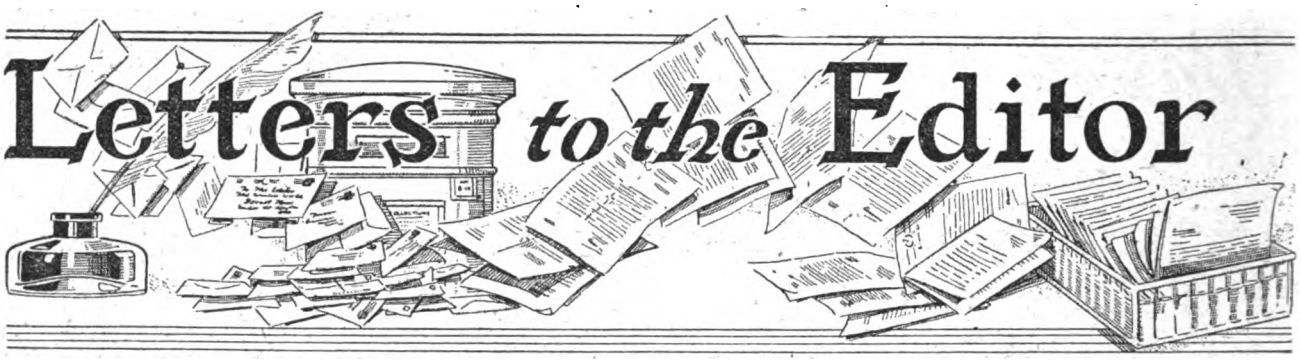

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

THE REGIONAL SCHEME.

Sir,—I cannot understand your attitude towards the Regional Scheme, involving, as it does, dual-wave, high-power transmissions.

You have recently described a series of excellent receivers, which you state will function satisfactorily with the advent of the new conditions. Surely it is up to listeners to bring their sets up to date rather than retard the progress of efficient transmission.

The power used in the tests from Brookman's Park, while adequate during daylight, is only just sufficient, at 100 miles from the transmitter (the limit of its range) to overcome interference from foreign stations after dark.

Lowestoft. A. E. MANNING.

Sir,—The views which you expressed in your editorial in the issue of October 16th will, I think, be endorsed by very many of your readers. There has, in my opinion, been too much confidence shown by the B.B.C. in the success of the regional stations.

Brookman's Park is, of course, a remarkably fine achievement as an engineering job, and the technical staff of the B.B.C. are entitled to be proud of it, but whether the regional scheme is the best solution to providing satisfactory broadcasting in this country has yet to be proved. The B.B.C. has always contended that they have to cater for the crystal set user and that they are not entitled to force him to buy a valve set, but now that they have rendered so many valve sets obsolete because of the power of the new transmitter, how are they going to reconcile this action with their attitude of the past? Nobody wants to stop progress, and no doubt the designs for receivers which *The Wireless World* produces will be a complete answer to the requirements of selectivity, but is it fair that the B.B.C. should have the power to compel listeners to spend money on buying new sets, or on bringing their old sets up to date? It seems scarcely right. "FAIR PLAY."

Golders Green.

Sir,—Your views in the Editorial of *The Wireless World* issue of October 16th are so remarkable that I feel a little explanation is due, and so I am setting out one or two points that you may care to reply to.

With regard to the new Regional station, may I ask why all the concern for listeners around this station, including London and suburbs?

When the Daventry station, 5GB, was started up I do not recollect any great sounding of trumpets from you, and I, incidentally, lived about 12 miles from this station at that time and had to get over the difficulty as best I could, and many other people did the same. We did not even bother you or the B.B.C. about it, but adapted our sets to suit.

Are we to assume that your outburst is due to the trouble being a little nearer you, in the Brookman's Park transmitter? As for the Press outcry, well, that should go the way of most of their articles, and I sincerely hope will cause no fear at Savoy Hill.

But now we come to a serious side of the question. What of the new receivers designed especially for the Regional Scheme? Are the manufacturers' claims all wrong? Is it impossible to design a sufficiently selective set?

What of your own articles *re* means for obtaining selectivity? Are these no good, too? Or do you suggest that listeners should retain their old sets and that the B.B.C. should make their strides of progress to suit.

And last, but not least, would not this latter way hit the radio trade badly?

Come! We who are old readers do not like to see you indulging in what appears to be a fit of temper because Savoy Hill have not told you why the new station did not take over on October 14th as scheduled, and this is the first thing that will occur to some of your readers when reading your Editorial.

You are surely not averse to progress, and your technical experts should be able to deliver we poor amateurs from the paths of unselectivity unto the future of selectivity.

We look to you to lead the way technically. Let the newspapers do the grumbling; no one takes any notice of them, anyway. W. H. CHIPPERFIELD.

London, W.12.

Sir,—You ask, "Must the Regional Scheme be scrapped?" Certainly not. The B.B.C. exists to give the best possible service to the greatest number of listeners. Therefore the fact that those within a few miles of the transmitter have in the past been unduly favoured is no reason why this monopoly of easy and good quality reception should continue. It will be necessary now for them to use selective sets, but they will still be much better off than those 100 miles away and near the coast.

It will mean a little trouble for the minority, but the majority will immensely benefit. As for the Continental stations, I often hear them and can say that their programmes, on the whole, are distinctly inferior to those given by the B.B.C., and as all announcements, talks, etc., are naturally given in the native language, comparatively few English people can understand them. Of course, there are specially good items at times, but these do not occur sufficiently often to make their reception a vital question. ARTHUR HOBDAY.

Margate.

SPARE APPARATUS.

Sir,—May I appeal through the columns of your magazine for the gift of any spare wireless gear that may be at the disposal of your readers.

This mission for social work among East End boys is unfortunately very cramped for funds. We have started a wireless class, and despite the enthusiasm of the boys we are painfully short of gear; in fact, we have practically nothing at all.

If any of your readers will send to me at this address, anything they are willing to give, I shall be most grateful.

Those who respond to this appeal will have the satisfaction of knowing that their gifts are being used to the utmost advantage, and also that they have been the means of bringing a good deal of happiness to those whose opportunities for enjoyment are at the best somewhat limited. W. A. CROWE.

London, E.2.

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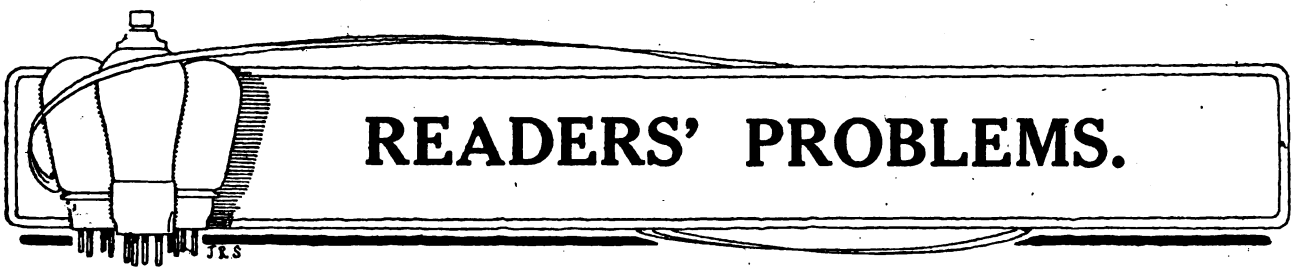

READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Multiple Battery Cables.

Is there any reason why a commercial five-way battery cable should not be used for connecting up the "New Kilo-Mag Four"? I believe that the use of these cables in highly sensitive receivers is sometimes responsible for instability. T. C. A.

As all the circuits of this set are isolated by means of decoupling resistances and condensers, it is impossible that any interaction should take place between the various battery leads, and consequently there is no risk in using this form of connecting cable.

oooo

"Record III." Transformers.

Will you please tell me if it would be permissible to wind the primary and neutralising sections of the "Record III" medium-wave H.F. transformer over the secondary winding, instead of underneath it? Of course, these coils would be carried on ebonite spacing strips placed over each rib of the former. J. R. S.

From the point of view of electrical efficiency, it is quite immaterial which form of construction is adopted; that illustrated in the descriptive article offers the advantage that the fragile primary windings are protected from harm by the secondary. Needless to say, the spacing between the coils should be exactly as described, and the single-turn neutralising coil should be carried on extensions of the spacing strips.

oooo

Larger Condensers Permissible.

Would it be permissible to use variable condensers of 0.0005 *mfd. for tuning the secondary and H.F. transformer circuits of the* "Wireless World *Kit Set"? I already have spare condensers of this capacity, and should like to use them if there is no serious objection.* N. H. C.

Tuning condensers of 0.0005 mfd. capacity can most certainly be used throughout in this receiver, provided that they have not exceptionally high minimum value. It should be pointed out, however, that tuning will be slightly more difficult, as the angular displacement of the vanes corresponding to a given wavelength change will be less than when the specified capacity is used. Of course, this slight disadvantage could be overcome by redesigning the coils, but this course would entail some reduction in sensitivity, and is not recommended.

With condenser values as specified, it will be found that the three dials run in step reasonably closely over the tuning scale; this will not hold good if alterations are made.

oooo

L.F. Potentiometers.

I am using an anode potentiometer for controlling the volume of my four-valve set (H.F. amplifier and anode bend detector, followed by resistance- and transformer-coupled L.F. stages). I am told that the same effect can be obtained by using a "grid potentiometer." Will you explain how this device is connected, and also say if it is superior to the method at present in use. V. D. S.

These two methods of volume control are shown diagrammatically in Fig. 1. The anode potentiometer which you are already using appears in sketch (*a*).

As you will see from diagram (*b*), grid potentiometer control is effected by replacing the usual fixed grid leak by a high resistance (of the value normally chosen for working in association with the coupling condenser). A sliding contact on this resistance is connected to the grid of the first L.F. amplifier in such a way that any desired proportion of the total signal voltage existing across the leak may be applied. This method has no advantage over the other scheme, except in the matter of cost, and often in convenience of wiring. A high-resistance potentiometer of the grid leak type is readily obtainable, and is quite inexpensive, while one's choice in the matter of suitable resistances for the anode circuit is somewhat restricted, and the majority of components having sufficient current-carrying capacity are considerably more expensive.

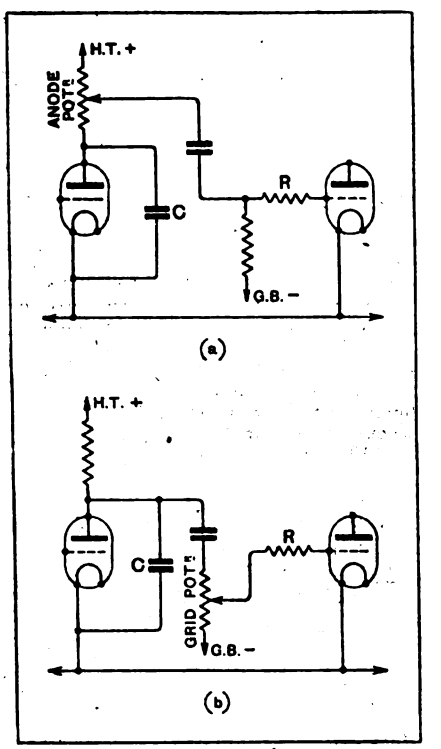

Fig. 1.—Two methods of post-detection volume control, whereby input from the detector to the L.F. amplifier may be regulated. In each diagram (c) represents the detector anode by-pass condenser, and R the conventional H.F. stopping resistance.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Adjusting Detector Bias.

My set is on the lines of the original "Everyman Four," but with a screen-grid H.F. amplifier. Is there a simple method of setting detector-grid bias other than the usual procedure of making this adjustment when listening to actual signals? I am aware of the fact that this can be done by inserting a meter in the anode circuit and balancing out the steady D.C. current, but should imagine that this is rather difficult. E. H. W.

We agree that the balancing method is not too easy to apply, but very much doubt if it is possible to improve—from the strictly practical point of view—upon the usual procedure. If adjustments of bias are carefully made when listening to really weak incoming signals, it is generally possible to find the best setting without much trouble.

250,000 Times Amplification!

Do you consider that it would be practicable to set up two H.F. stages similar to those included in the "Record III." receiver? If you think that it would be possible to construct such a set satisfactorily, I should build it in a standard "Wireless World" four-compartment cabinet, mounting the aerial tuning coils and their condenser in the base of the compartment. C. L.

By observing extreme care at every point—particularly with regard to screening and decoupling—it would be possible to build a "2-H.F." set with something approaching the stage amplification of the receiver in question; but unless you have had considerable experience we should be doing you a disservice by recommending that you should proceed with your plan.

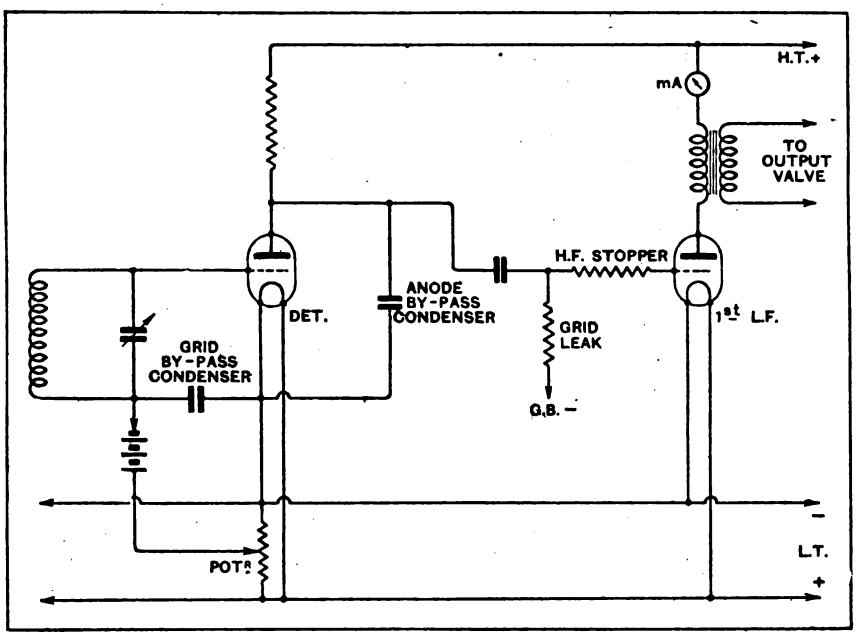

Fig. 2.—Converting a first-stage L.F. amplifying valve into a valve voltmeter: a simple method of making an accurate adjustment of detector grid bias.

A satisfactory way of making a comparative measurement of the rectified output from the detector is shown in Fig. 2; this is readily applicable to your own set, and requires no other apparatus beyond a fairly sensitive milliammeter, which is inserted in series with the anode circuit of the first L.F. amplifier. The procedure is to convert this valve into an L.F. signal rectifier by approximately doubling its negative grid bias, and, while listening to a signal of constant amplitude (such as a tuning note) to adjust grid bias until the milliammeter reading is at maximum.

Although a detector potentiometer is not usually considered as necessary when a valve of comparatively low impedance is used, we certainly think it should be included when one is attempting to make a really accurate adjustment, and accordingly this feature is shown in our diagram.

A Faulty Transformer Primary.

My set (detector followed by two transformer-coupled L.F. stages) works reasonably well, provided that the H.T. pressure is not increased beyond 60 volts. As soon as an attempt is made to apply sufficient voltage for good quality and adequate volume, violent crackling noises are heard in the loud speaker, and signals sometimes fade away altogether. Can you suggest what is wrong? From replies to other correspondents, I suspect that one of the transformer primaries has developed a fault, but the usual "phone and battery" test seems to suggest that everything is in order. N. P. R.

We think that you are correct in assuming that one of the transformer primaries is responsible for the trouble; it seems that a rather unusual (but by no means unknown) type of open circuit in the windings has developed, and that this manifests itself when the current passing reaches a certain fairly critical value. A fault of this kind would not be revealed by the usual tests, and we suggest that you should attempt to locate the defective component by temporarily shunting the phones or loud speaker in turn across the anode circuit of the first L.F. valve and then across the transformer primary. If, with this connection, the trouble persists, it may be assumed that the first stage transformer is at fault; if, on the other hand, the set works well, it is probable that the other is to blame.

Of course, you must not lose sight of the fact that the loud speaker or the output choke (or transformer, if one is used) may also cause a similar trouble.

o o o o

"Designing an Eliminator."

With reference to the article under the above heading, which appeared in your issue for October 2nd, will you please tell me if the centre-tapped double 0.1 mfd. condenser mentioned need be of any special form, or will it be satisfactory to use two ordinary condensers connected in series, taking the negative supply lead from the junction between them? I refer, of course, to the arrangement shown in Fig. 1 (c) of the article. W. H.

Any good condensers, with the usual commercial tolerance as to their precise values, will do for this purpose; they are connected in the manner you state.

FOREIGN BROADCAST GUIDE.

KOVNO

(Lithuania).

Geographical position: 54° 55′ 00″ N. 23° 56′ 00″ E.

Approximate air line from London: 1,015 miles.

Wavelength: 1935 m. Frequency: 155 kc. Power: 7 kw.

Time: Central European (60 minutes in advance of G.M.T.).

Standard Daily Transmissions.

G.M.T. 11.00 and 17.00 weather and news; 18.30 and 20.00 concerts. Usually closes down at 21.00

Dance music 20.00—21.15 (Sats. only).

Male announcer. Call: *Allo! Allo! Lietuvoss Kaunas*, with, at times, French translation: *Ici Poste de Radiotélephonie de Kovno.*

Opens transmission by playing a gramophone record.

Interval Signals: a stroke on a gong.

Closes down with a few bars of the Lithuanian National Anthem.

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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FUNDS FOR THE NEW 5SW.

IN our editorial in the issue of October 23rd, we urged once again that some definite step should be taken towards establishing a satisfactory Empire Broadcasting service. We traced the history of the various stages by which 5SW was established on its present inadequate basis, and showed how hard a struggle it had been in the face of opposition or inertia to achieve even so poor a start as 5SW has proved itself to be.

Our editorial appears to have attracted immediate attention, for within a day or so a comment appeared in the daily Press suggesting that new plans were on foot at the B.B.C. in regard to Empire Broadcasting policy, although, on enquiry, we found that the Corporation was not prepared to say more than that the future of short-wave broadcasting from this country was being considered, and negotiations on the question were proceeding. Any news which indicates activity is better than no news, and so we look forward to some more definite announcement at an early date.

We have always questioned whether short-wave broadcasting to the Empire was legitimately a part of the activities of the British Broadcasting Corporation. Obviously, at the time that the proposal was first put forward, the B.B.C. appeared to be the most convenient authority to undertake the task, but they have not shown sufficient enterprise or interest in the project to entitle them to retain the control, unless they are prepared immediately to take some worth-while action in the matter.

The Empire Marketing Board.

We know that the excuse, if we may so term it, for inactivity on the part of the B.B.C. has always been that they have no authority for expending B.B.C. money on a short-wave Empire station, and that without money it is impossible for them to make progress. Various suggestions have been made as to who should bear the cost; the Colonial Office has been held responsible by some, whilst it has even been proposed that Colonial listeners themselves should contribute something by way of a licence fee for listening to the Empire station. But such proposals have not been developed, as no satisfactory case could be made out for them. One must look around to find some authority which could benefit directly from the establishment of an efficient service, and one comes to the conclusion that of the choice of authorities on whom the task of financing the short-wave service could be imposed, the most obvious is the organisation known as the Empire Marketing Board. This Department has as its object the development of trade within the Empire and, we understand, the financial grants which it receives can legitimately be expended on enterprises which stimulate inter-Empire commerce.

We cannot imagine for one moment that any objection would be raised to the Empire Broadcasting short-wave service being utilised to help in such an object as this. Market intelligence, talks on Empire development, and a hundred-and-one things which would go towards uniting more closely the units of Empire could all be justified. No one, we think, would quibble at the Empire Broadcasting service being put to such a use as this, particularly when by this means the problem of funds for programmes and the stations could be solved.

It is, perhaps, rather presumptious on our part to discuss what should be the policy of such an organisation as the Empire Marketing Board, but we would like to make it quite clear that the suggestion is one which is put forward in the honest belief that it may be helpful as a solution of the Empire Broadcasting impasse, whilst at the same time being directly beneficial to the cause which the Empire Marketing Board champions.

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Interference From Brookmans Park

Some Hints on Improving the Performance of Existing Sets.

ALTHOUGH all the alarmist reports that have appeared in the daily Press need not be taken too seriously, it is now clear that many thousands of listeners in London and the Home Counties are seriously affected by the opening of the new 2LO, sometimes to the extent of being unable to receive even an alternative programme from Daventry 5GB. It will be small consolation to these sufferers to realise that the inauguration of the twin transmissions will intensify their troubles; in many cases there will be mutual interference between "London No. 1" and "London No. 2," and neither station will be received without a background of the other until their receiving apparatus is altered.

If it is admitted that the new scheme of transmission is beneficial to the majority, blame for this state of affairs must be laid to the general tendency to simplify broadcast receiving apparatus to a greater extent than is really permissible in view of the rather high standard of performance that is customarily expected. It is perfectly easy to produce a fool-proof and inexpensive set capable of receiving either of the twin stations only at a distance of even half a mile from Brookmans Park, but serious complications arise when a wider choice of programmes is demanded under such difficult conditions. Readers of this journal are in better case than the general public; since the Regional scheme was first proposed, special attention has been devoted in these pages to the question of eliminating interference. It has been made clear that, broadly speaking, exceptional selectivity is brought about by using tuned circuits of lower resistance than usual, or, better, by adding to the usual number of tuned circuits of average "goodness"; unfortunately, either procedure tends slightly to increase the complexity and cost of the receiver. Until ganged tuning becomes more popular and widely available, we must face the fact that many listeners (their number will increase as and when the Regional plan is extended to other areas) will have to master the niceties of handling a multi-control receiver. Approached in the right way, it is not a very difficult art to acquire.

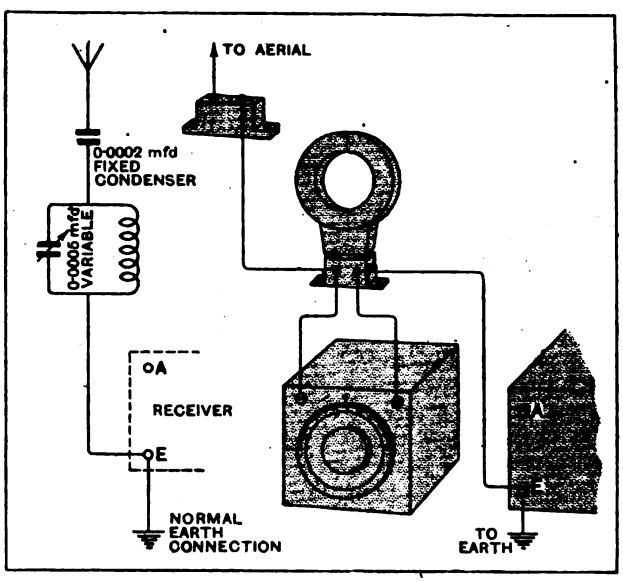

Fig. 1.—Theoretical and practical diagrams of a simple but effective aerial tuner. The coil must be mounted in inductive relation with the aerial-grid winding of the receiver.

It is admittedly none too easy to make internal alterations to an existing set, but fortunately it is possible to restrict the spreading of strong local signals by making comparatively simple external modifications and additions. All too often, many of the modifications that are customarily recommended add nothing to the *real* selectivity of the receiver, and are apparently more or less effective only because they reduce the signal input to the receiver. These methods have their uses, provided one does not expect too much of them, and realises that all signals, wanted as well as unwanted, will be reduced in strength. It is the purpose of this article to describe simple modifications whereby almost any set can be improved, and, as many readers will doubtless have non-technical friends

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Interference from Brookmans Park.—

who are in difficulties, an attempt will be made to treat the subject in the simplest possible manner.

Before beginning to discuss the more helpful and important additions, it will be as well briefly to survey some of the minor alterations that can be introduced, and which contribute at least something to the overall selectivity of a receiver. The use of anode bend detection, if substituted for the more popular grid method, is certain to improve matters; not only does it impose less damping on the preceding tuned circuit (when matters are properly arranged), but its well-known lack of sensitivity to small signal voltages is of distinct benefit in eliminating a strong background of interference which might well be present when using the competing method of rectification.

Inherently Selective Circuits.

The selectivity of tuned circuits of the kind included in ordinary sets can always be increased by arranging to use a higher ratio of capacity to inductance than is usual—in other words, by using a comparatively small coil with a large tuning condenser. This plan can, in many cases, be tried without involving any serious changes; what one should do is to use the smallest coil which will enable the longest wavelength desired to be received with the particular value of tuning condenser fitted to the receiver. It may be added that this plan is generally most successful when applied to relatively simple detector-L.F. sets, and that in carefully designed receivers with H.F. amplification its inclusion is likely to give rise to an appreciable falling-off in range, and even in quality.

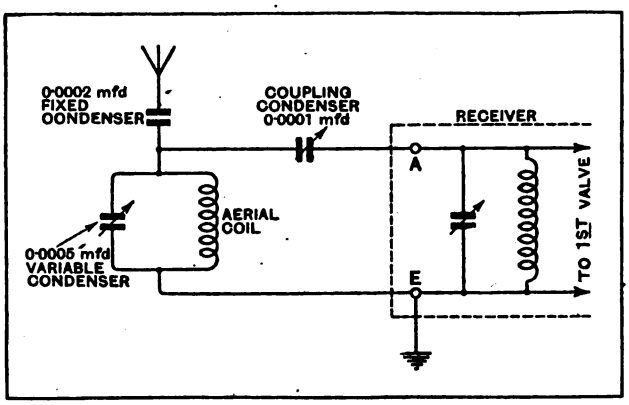

Fig. 2.—Circuit diagram of a capacity-coupled aerial tuner.

It will be generally appreciated that the design of an H.F. transformer is a compromise between the requirements of maximum amplification and selectivity, and that the designer's original conception of the best ratio between primary and secondary turns may now stand in need of some revision, in view of changing conditions. It is quite permissible to try the effect of removing a few primary turns; for information to the reduction in signal strength likely to be brought about by this alteration, the reader is referred to a recent article on the subject in these pages.[1]

Turning to the subject of alterations of the kind likely to effect a definite and clearly perceptible reduction of interference, mention must first be made of the somewhat drastic expedient of reducing aerial length. This is widely recommended nowadays, but it always seems to the writer to be illogical, as exactly the same effect can be obtained by reducing aerial coupling by inserting a small (preferably variable or semi-variable) condenser in the lead from aerial to set, by reducing the number of turns in the aerial circuit when an "aperiodic" coupling is used, or by varying the inductive relationship between aerial and secondary coils where provision for this adjustment is made. This plan enables the user to make full use of a long aerial when the set is used at times when the interfering station is silent, or when receiving wavelengths on which interference is not pronounced.

It cannot be denied that, to the non-technical user who has no knowledge of the technical details of his set, and has not access to a well-informed source of information, the rather wasteful expedient of actual amputation of the aerial wire is likely to meet the case well enough, but to be effective in difficult situations it must be carried to such lengths that the reception of distant stations becomes next to impossible. It should be made clear that, even in North London, almost any set except a portable is susceptible to this treatment, and, always provided that nothing more than the Brookmans Park alternative transmissions are desired, satisfactory results are attainable by making progressive experimental reductions in aerial length.

For some time past, writers in this journal have urged the desirability of reverting to the loosely coupled and separately tuned aerial circuit which has found a place, almost as a matter of course, in commercial apparatus since the earliest days of wireless telegraphy—long before the era of telephony. It is by no means difficult to add it to the majority of sets in the manner shown both diagrammatically and pictorially in Fig. 1. The coil, which must be of a size suitable for the wave-range to be received—a No. 60 will be suitable for the medium broadcast waveband when used in conjunction with a normal aerial and a 0.0005 mfd. tuning condenser—is mounted outside the receiver cabinet, and in such a position that it is in inductive relationship with the normal internal aerial coil: a spacing of several inches is generally necessary, and the correct position is best found by trial.

Continuously Adjustable Condenser-coupling.

A somewhat neater arrangement is made possible by using the capacity-coupled aerial tuner shown in Fig. 2, in which transference of energy from aerial to grid coil is controlled by a variable condenser. For this purpose, a capacity of something considerably less than 0.0001 mfd. is generally sufficient—a neutralising condenser will often do quite well—but the value shown is recommended where an aperiodic coupling arrangement is included in the set itself. Connections of the aerial tuner under these conditions are as shown in Fig. 3.

[1] H.F. Transformer Design, by A. L. M. Sowerby. *The Wireless World*, October 23rd.

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Interference from Brookmans Park.—

It is essential that interaction between external and internal coils should be mainly through the coupling condenser, and any appreciable direct magnetic effect is to be avoided. To this end, it is desirable to interpose an earthed metal screen between the coils, or, best of all, to enclose the aerial tuner in a metal box. This plan has the advantage of neatness, as all the apparatus

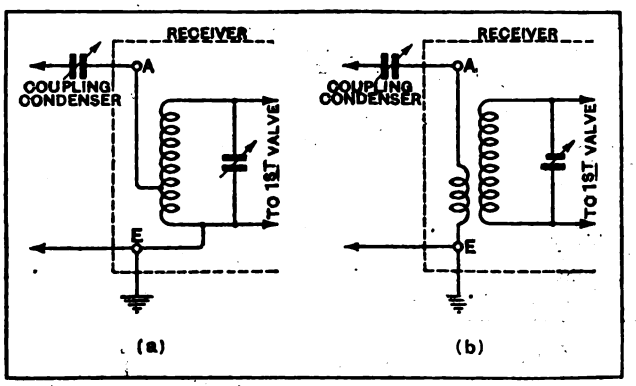


Fig. 3.—Internal connections of the tuner shown in the preceding diagram to (a) auto-transformer coupled aerial set and (b) magnetically-coupled "aperiodic" circuit.

—coil, tuning condenser, and coupling condenser—can easily be accommodated in a container measuring not more than 6in. cube.

It should be emphasised that it is risky to attempt to add either of these loose-couplers to any receiver, including a stage of H.F. amplification with an un-neutralised three-electrode valve. Such sets depend for their stability to a great extent on the effects of aerial loading; this loading is largely removed when these devices are adjusted in an effective manner from the point of view of selectivity.

Another minor difficulty may be encountered where the set normally includes a directly coupled aerial, as shown in Fig. 2. In such cases, the inherent capacity of the aerial is added to that of the tuning condenser, and when it is removed the circuit will generally be incapable of being tuned over the broadcasting wave-bands. The remedy is to fit suitable input coils.

How to Operate a Loose-coupler.

A still more ambitious loose-coupler is *The Wireless World* Selectivity Unit, described in the issue of April 25th, 1928; the circuit diagram of this device is reproduced in Fig. 4. It includes a standard "Everyman Four" aerial-grid coil, tuned by a variable condenser (C_1) of 0.00033 mfd. The coupling condenser (C_2) has a capacity of 0.0001 mfd. This unit is similar to the capacity-coupled aerial tuner shown in Fig. 3, and is connected to the aerial and earth terminals of the receiver in the same way.

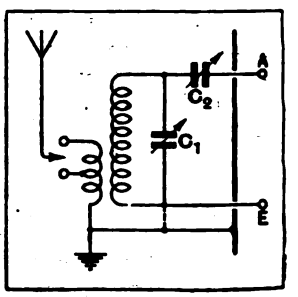
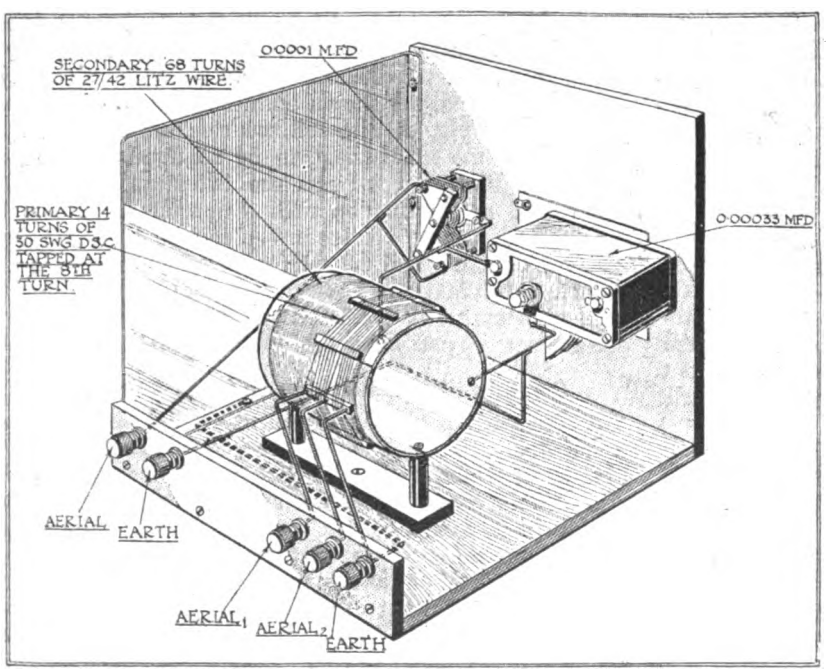


Fig. 4.—Circuit diagram of "The Wireless World" Selectivity Unit.

Some little trouble—but not more than can be overcome by assiduous practice—will be encountered by the less experienced when first operating a reacting detector set (without H.F. amplification) to which a two-circuit aerial tuner has been added. Receivers without feed-back to the input grid circuit are quite easy to work if one remembers that all the tuned circuits must be kept approximately "in step" while searching for signals; this is quite easy when a few "landmarks"—stations of which the wavelengths are known—have been found.

It is usual to recommend that the beginner should start operations with a very close coupling between aerial and secondary circuits, but it seems to the writer to be very doubtful if this is the best course, as "double-humped" tuning may be produced; this is most confusing, as a given transmission may be receivable at two distinct condenser settings.

Generally speaking, it is best to acquire experience of tuning when the local interfering station is silent, and to concentrate on a transmission providing a large but not overpowering input. If the suggestion offered in the preceding paragraph is adopted, the coupling will be made very loose by moving the aerial coil to a distance of several inches from the internal grid inductance, or, if a capacity-coupled circuit is used, by setting the control condenser at a very low value.



Disposition and wiring of components in "The Wireless World" Selectivity Unit. A vertical metal screen is fitted.

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RADIO in FRANCE

Apparatus of Interest seen at the PARIS SHOW

By A MEMBER OF THE STAFF.

MY visit to this year's Paris Show has been a disappointing one. It was difficult to realise that twelve months had elapsed since I last toured the stands in the Grand Palais. The apparatus, in general, had undergone little or no change, and most of last year's designs still flourished. I was again greeted as I went from stand to stand by the pairs of tuning dials indicative of the superheterodyne. Not even the dials themselves had changed, so I set out in search of departures from these highly selective sets which seem to have assumed a life eternal.

My comments of last year on the survival of the superheterodyne brought forth much criticism from French readers, and three reasons were brought forward as to why the manufacturers in France favour this class of set. These reasons were (1) that the majority of listeners are not permitted to erect outdoor aerials, partly because of the unsightly effect and also owing to a fear of damage by lightning, a seemingly futile reason, (2) a high degree of selectivity was demanded, combined with the reliable reception of programmes from abroad, and (3) patent royalties, not being based on the number of valves, permitted of this class of multivalve receiver. None of these reasons seems sufficiently convincing, yet it is the third which contains the truth, for in France the master patents have not been administered in the same convenient manner as they have in this country, and neither are those all-important patents just expired or expiring, as is the case here. Unless the problems of patent administration and validity are quickly solved France will find herself hopelessly handicapped in the production of radio gear.

This universal production of superheterodyne sets is not the only point indicative of the radical difference existing between two almost adjoining countries. There are practically no portables, and the home constructor, as a class, is non-existent. There are no kit sets, neither are there specialised components for the amateur comparable with the extensive production of such apparatus in this country. Components are exhibited, yet with the exception of ingenious condenser mountings there is no single example of a component in which progressive design or invention is revealed. Components shown last year appear again this year without modification, and, in fact, there are not even copies of those many specially designed parts found on the British market and so essential to obtaining the best results. French components sell to the set manufacturer, and not

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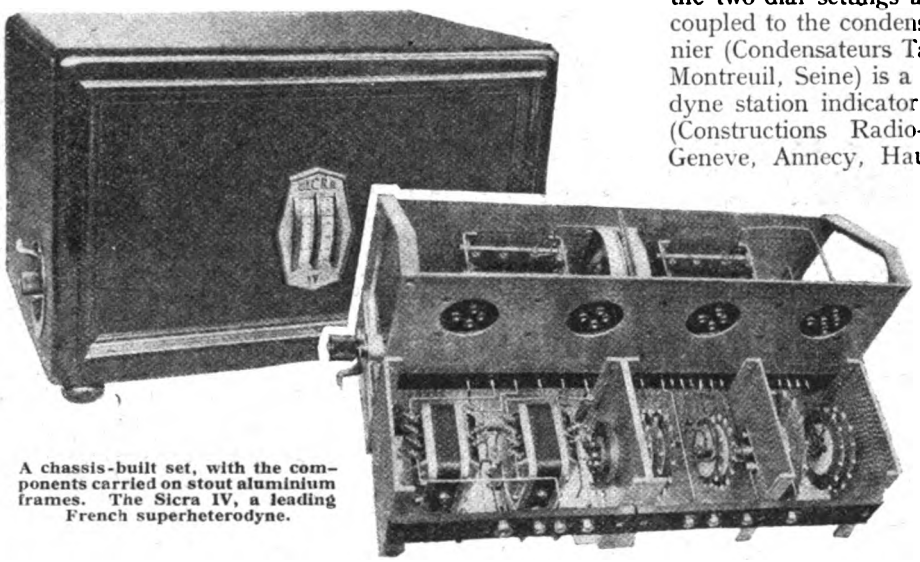
Radio in France.—

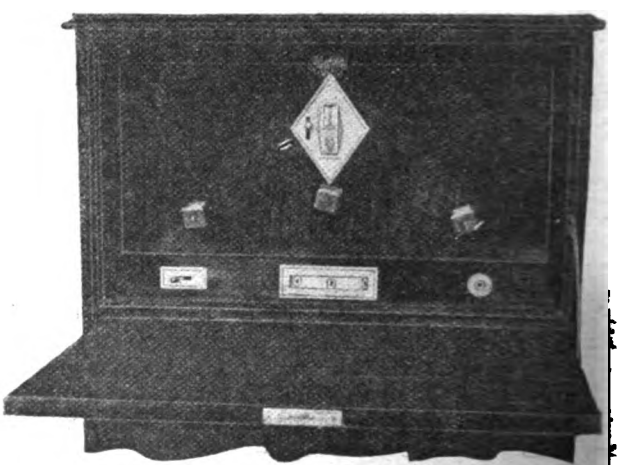
the amateur, so that high technical merit is probably overruled by economic requirements.

As a stand-to-stand report would resolve itself into describing a multiplicity of circuit combinations of the superheterodynes, a few outstanding points of design are all that will interest the English reader. Tuned H.F. stages preceding the first detector are now practically non-existent. A special two-grid type of valve is used in many of the sets as a first detector, as a means of combining the frequencies. As with the English receiver, two-wave ranges are invariably provided, a complicated switch being used to change the connections of frame, oscillator, and reaction. Screen-grid valves have in a few instances found their way into the intermediate amplifier, but as stable amplification already exists on the long intermediate wavelengths the advantages gained by the change are questionable. Long-wave intervalve couplings are, in almost every case, simple air core transformers of the fine wire aperiodic variety. In the majority of the sets a horizontal ebonite panel carrying the apparatus on the under side and the valve legs on the top is secured to the vertical front panel, behind which there is ample space to accommodate the two tuning condensers and the many forms of tuning indicators.

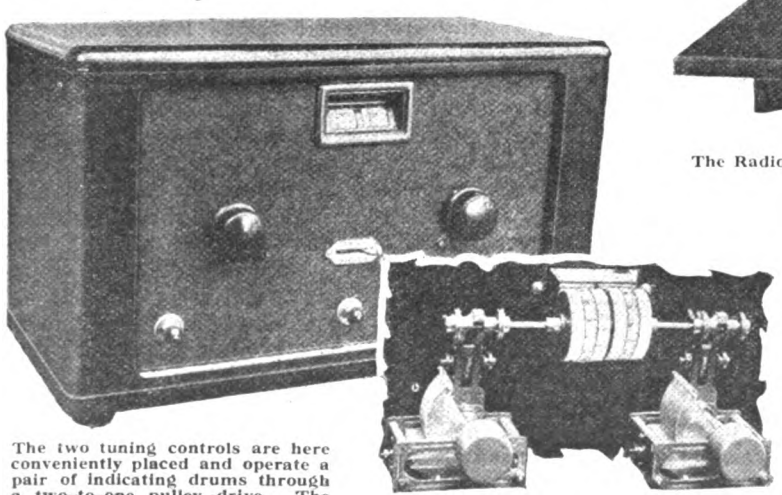


A chassis-built set, with the components carried on stout aluminium frames. The Sicra IV, a leading French superheterodyne.

Last year I described some of these indicators, their action being based upon the graphical representation of the two-dial settings associated with pointers which are coupled to the condenser spindles. The Autorex Tavernier (Condensateurs Tavernier, 71, Rue François-Arago, Montreuil, Seine) is a typical example of a superheterodyne station indicator. Another model, the "Grillet" (Constructions Radio-electriques Grillet, Avenue de Geneve, Annecy, Haute Savoie), consists of a sliding indicator interlocked by rack work with the two condensers. Three separate slides are arranged in this model, and in moving from one to the other a wave-range switch and indicator are actuated. One of the most ingenious presented a rectangular screen on its front panel, and the operating of the knobs caused a spot of light to move to a predetermined point indicating the station required. Another useful form of station indicator is found in the "Cryptadyne VII" (Radio-Industrie Cryptadyne, 25, Rue des Usines, Paris). In this receiver a pair of dials are labelled with the stations in the long and short wave bands. These dials are interlocked with scales, which are viewed through apertures immediately adjoining the scales of the tuning condensers. In the apertures one reads the condenser settings required for the given stations.



The Radiola six-valve superheterodyne, possessing one of the most attractive of panel layouts.



The two tuning controls are here conveniently placed and operate a pair of indicating drums through a two-to-one pulley drive. The Strobodyne Diplex with Arena condensers.

Output L.F. amplifiers incorporated in these superheterodynes did not include

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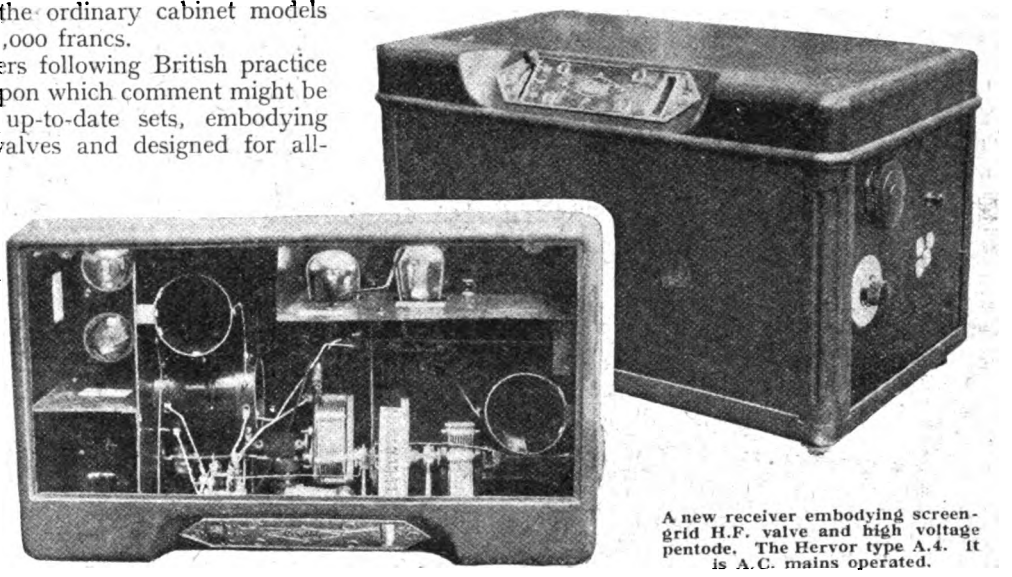
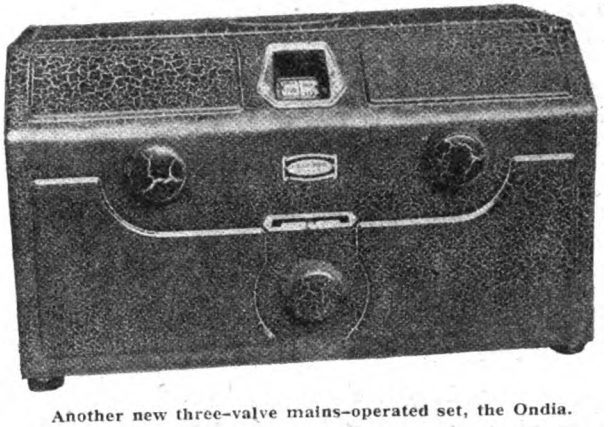
Radio in France.—those refinements necessary for distortionless amplification, a circumstance suggesting that the superheterodyne principle itself does not permit of quality reception. Prices differ widely, varying in the ordinary cabinet models between about 1,000 and 3,000 francs.

In the search for receivers following British practice two examples were found upon which comment might be made. These are really up-to-date sets, embodying screen-grid and pentode valves and designed for all-mains operation. Both were three-valve sets, and obviously designed with a view to mass production. The "Ondia" (Le Matérial Ondia, 2, Route de Paris, Boulogne-sur-Mer), is beautifully finished in a pressed metal case, with drum dial exposed in an aperture on a top edge bevel. Being completely sealed I had no opportunity of examining the interior, but it was obvious from certain details in design that the manufacturers were in a unique position in the matter of mass production, and it transpired that their principal business was that of pressings and turned parts. This receiver, it is hoped, marks a turning point in French radio practice.

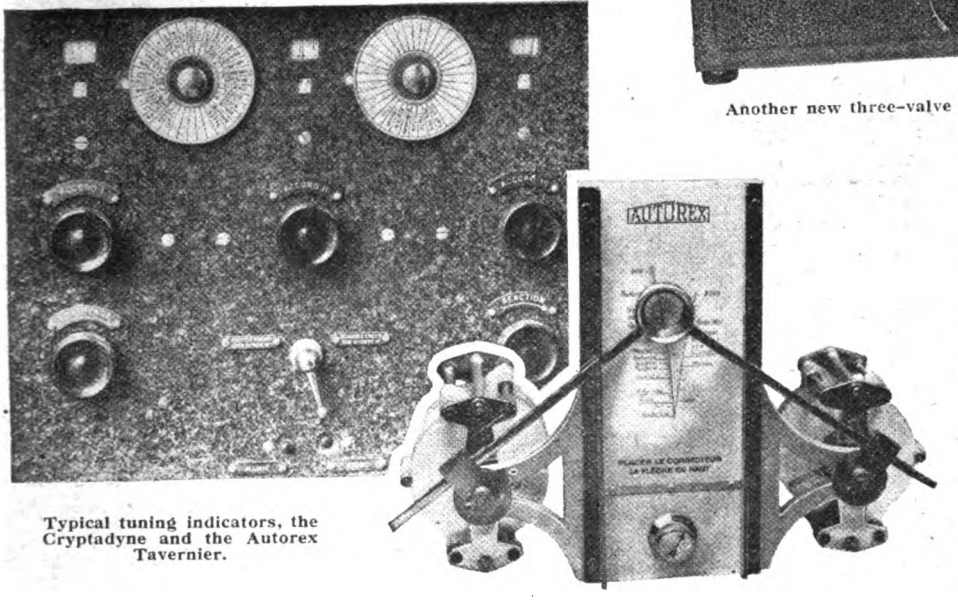
The other receiver, the "Hervor" (Etablissements Herbelot et Vorms, 13, Passage des Tourelles, Paris), is contained in a large pressed metal cabinet with rounded corners, following Philips' practice. Its three Philips' valves correspond with the S4V, the 164T, and the PM24A, provision being made to feed this output pentode with an anode potential of 300 volts. Complete with valves, the price of this set is about £20. It is interesting to note that the French sets designed for use with mains include a three-point connection to the supply, the extra lead being a tapping on the transformer primary to allow for voltage variation. In addition, the "Hervor" is fitted with a control to further compensate for differences in the potential of the mains.



A new receiver embodying screen-grid H.F. valve and high voltage pentode. The Hervor type A.4. It is A.C. mains operated.



Another new three-valve mains-operated set, the Ondia.



Typical tuning indicators, the Cryptadyne and the Autorex Tavernier.

Over 120 different models were counted on the stands of the set manufacturers, of which probably not more than five per cent. are of the mains-operated straight-circuit type.

Oxide-coated filaments are now used in most of the French valves, giving to them greatly improved performance. Certain of the manufac-

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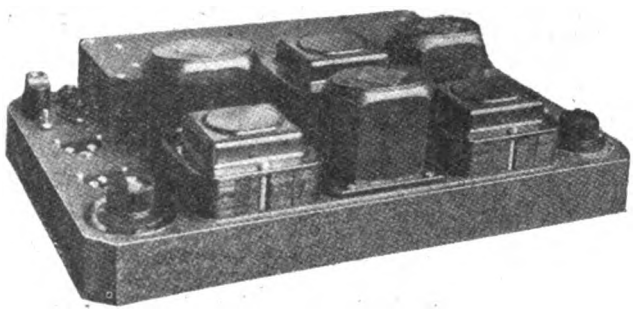
Radio in France.—

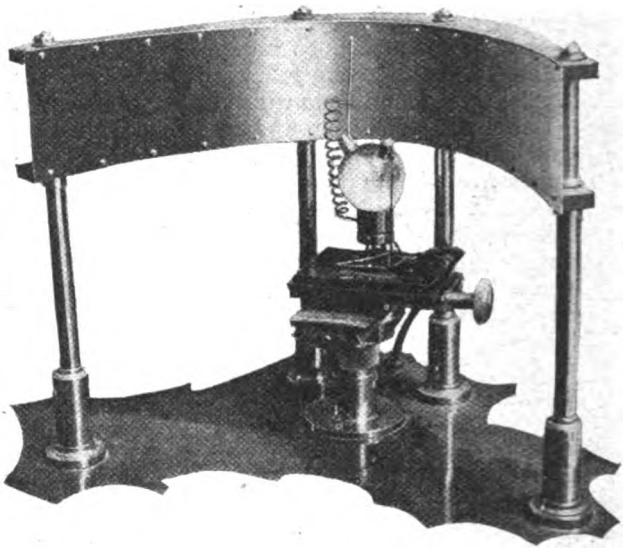
turers limit their output entirely to triodes, but others include well-finished specimens of screen grid and pentode. Indirectly heated valves have also made their appearance. Those readers whose radio experience dates back to before broadcasting will remember how they depended upon France for their supply of valves, and, in particular, had a high opinion of valves bearing the name Métal and Fotos. During the intervening period these valves have not possessed the characteristics to be found in the British products, but now, I find, that by the use of the oxide-coated filament Métal and Fotos valves have been greatly improved. By way of example, the Métal type D.W.702 is a power output valve with an A.C. resistance of 2,250 ohms and an amplification factor of 7, so that the mutual conductance is no less than 3.2, while the permissible grid swing is nearly 30 volts. Its filament passes 0.23 ampere at 4 volts. Another output valve, the D.X.502, passes 0.15 ampere at 4 volts, and



A mains-operated low-frequency amplifier by La Construction Radioélectrique. The circuit is a push-pull arrangement using an anode potential of 400 volts.

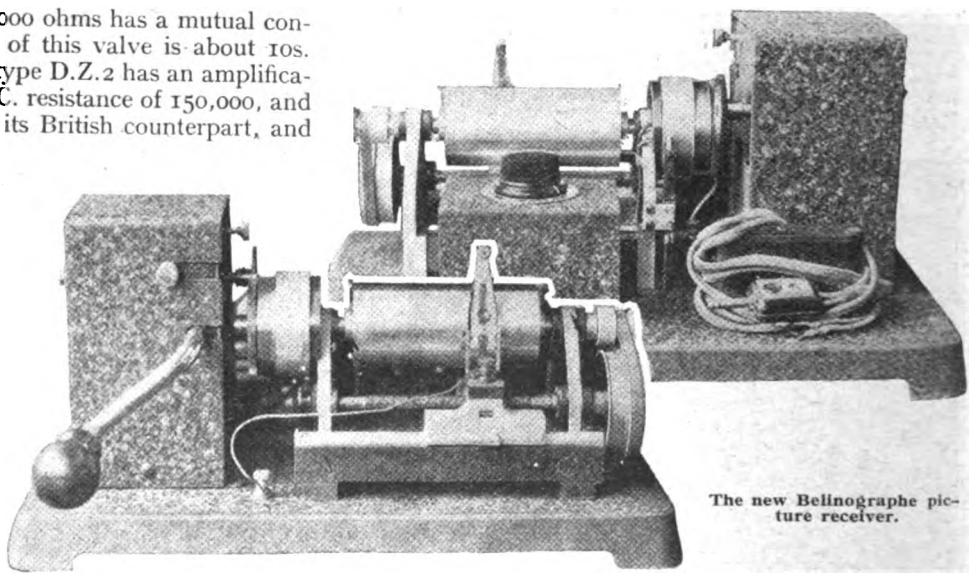
with an A.C. resistance of 2,000 ohms has a mutual conductance of 2.5. The price of this valve is about 10s. The Métal screen-grid valve type D.Z.2 has an amplification factor of 150, with an A.C. resistance of 150,000, and corresponds, therefore, with its British counterpart, and is priced at about 14s. A Métal pentode, the 3.D.X., which is known as the *trigrille*, sells at 16s., has a mutual conductance of 1.8, and takes a maximum anode potential of 150, the grid bias being 10 to 12 volts.

Data given in respect of Fotos valves shows that many of the popular L.F. types have a mutual conductance of 2. The Fotos pentode has a mutual conductance of 1.8, and a maximum anode potential of 120, with a bias of about 7.5. This valve is priced at about 14s. 6d. Of similar price is the screen-grid valve with amplification factor and A.C. resistance of 150 and 150,000 respectively. When indirectly heated and having very similar characteristics, this valve is priced at 16s. There is another series of valves, bearing the name Visseaux, with characteristics and prices closely corresponding to those just mentioned (J. Visseaux, 87 and 91, Quai Pierre-Seize, Lyon).



An interesting ultra short-wave transmitter with reflector. (Ateliers J. Carpentier.)

Picture receivers for home use are the principal exhibit on the Belin stand. The Belinographe machines are fitted with driving clutch, catch and contacts, and closely follow standard practice. Traversing of the cylinder is obtained by an auxiliary shaft, and by means of a double pulley the rate of traverse may be readily adjusted to satisfy the standards of picture analysis adopted in the various systems. The price of the machine is about £20.



The new Belinographe picture receiver.

Moving-coil loud speakers are still little in evidence, the principal exhibitors being the French B.T.H. and the Stellor (Etablissements A. Charlin, 148, Avenue du Maine, Paris). A patent royalty is collected in France in respect of the moving-coil loud speaker, which is perhaps a contributory cause in restricting its popularity.

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By Our Special Correspondent.

Those Land Lines.—A New Black List.—Regional Scheme Disclosures.

A Rumour Refuted.

Sunday, October 27th, was enlivened by the newspaper report that in the near future the B.B.C. would probably acquire its own cables for S.B. purposes. An astounding statement, which was instantly contradicted on enquiry at Savoy Hill. The Post Office maintains a jealous authority over all communications in this country, and considering the initial and upkeep costs of lines it is unlikely that any other organisation would covet the honour. (The cost of installing a modern cable with the necessary repeaters between London and Glasgow would amount to more than £400,000!)

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The Land Line Problem.

Nevertheless, mention of the land lines always gives rise to melancholy reflections in the minds of listeners who live beyond the service areas of 2LO and 5XX. No existing line is ideal for broadcasting purposes, and no amount of amplification *en route* can give Ireland or Scotland the quality of transmission which the pampered London listener has been led to expect as his birthright.

When the completed regional scheme holds sway every listener will be entitled to at least one direct wireless programme from his nearest transmitter.

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Hope for the North.

Meanwhile I hear that the Post Office (which, to its credit, has always striven to give the B.B.C. the best of the available lines) is taking broadcasting into account in the design of the latest cables. Before the end of the year Scottish listeners are likely to benefit from the opening of a new cable from Leeds, *via* Jedburgh, to Edinburgh, equipped with the most modern types of amplifier and capable of dealing with a much wider range of frequencies.

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German Enterprise.

Probably the best cables in the world for broadcasting purposes are those now in use in Germany. The German Post Office has worked hand in hand with the broadcasting authorities in the production of cables specially suitable for musical transmissions, and the result is the evolution of a new form of cable in the centre of which are several heavily insulated lines reserved exclusively for broadcasting purposes. It is stated that relays with the new cable, which runs from Berlin to Cologne, are singularly free from extraneous noises and distortion. The British Post Office is watching the experiment with interest, and it is highly probable that similar tests may be carried out over here.

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B.B.C.'s Birthday.

This year's broadcast birthday programme (from all stations on November 14th) is to be entitled "We are Seven." I understand that it is not intended to disguise the fact that the staff actually numbers 700, but is a reminder that this is their seventh anniversary.

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Tatsfield's Black List.

The Tatsfield receiving station of the B.B.C. has been conducting what might almost be called an inquest upon the remains of the Prague Plan. Ignoring the chaos in the Continental ether, the engineers have been concentrating on the interference caused to British stations, with "distressing disclosures." At the present time no fewer than ten Continental transmitters are heterodyning B.B.C. stations every night. Here is the black list:—Petit Parisien, Radio Vitus, Langenburg, Zagreb, Lyons, Simferopel (Russia), Moravska-Ostrava, Leipzig, Horby, and San Sebastian.

San Sebastian, by the way, is making honourable attempts to avoid Glasgow's wavelength, but seems unable to find a niche elsewhere.

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Regional Scheme Disclosures.

The Moorside Edge station is to have a bigger service area than Brookmans Park. This is one of a number of interesting official statements concerning the regional scheme made in the B.B.C. Year Book for 1930, which is timed to appear in a day or two.

The service area will be greater, partly on account of the longer wavelength—the highest medium wave available—and partly because the B.B.C. has been permitted to use masts 500ft. high, whereas owing to Air Ministry restrictions Brookmans Park has been limited to 200ft.

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The Unlucky Highlands.

When the London, Daventry and Northern regional stations are working it is estimated that a service of alternative programmes will be available to 75 per cent. of the population in the British Isles, leaving the remainder to be provided for by the Scottish and West Regional stations. The B.B.C. fear, however, that these two stations will have the hardest task, as they have to cover mountainous country. Indeed, it is frankly admitted that something like 2 per cent. of the population of Scotland will be left out in the cold. When the scheme is complete only 4 per cent. of the total population will be unable to get any alternative programme, and about 80 per cent. should be able to enjoy an alternative with the simplest receivers.

Regarding the completion of the scheme the writer says: "It is fair to give 2½ years more before everything is as it is planned to be."

FUTURE FEATURES.

London and Daventry.

NOVEMBER 11TH.—Armistice Day Service and "Journey's End."

NOVEMBER 14TH.—Peace Commemoration Dinner Speeches, relayed from the Guildhall.

Daventry Experimental (5GB).

NOVEMBER 11TH.—Service from the Cenotaph.

NOVEMBER 12TH.—Music by French Composers.

NOVEMBER 15TH.—"Une Voix dans le Desert," poem by Emile Cammaerts, music by Sir Edward Elgar.

Cardiff.

NOVEMBER 14TH.—"Empire Builders," the story of Bristol Merchant Venturers.

Manchester.

NOVEMBER 16TH.—Playwrights of the North.—7, "Mary's John," a comedy by Harold Brighouse.

Glasgow.

NOVEMBER 16TH.—"Weir of Hermiston," by Robert Louis Stevenson, dramatised by A. W. Yuill, adapted by Halbert Tatlock.

Belfast.

NOVEMBER 13TH.—An Irish and Scots Programme.

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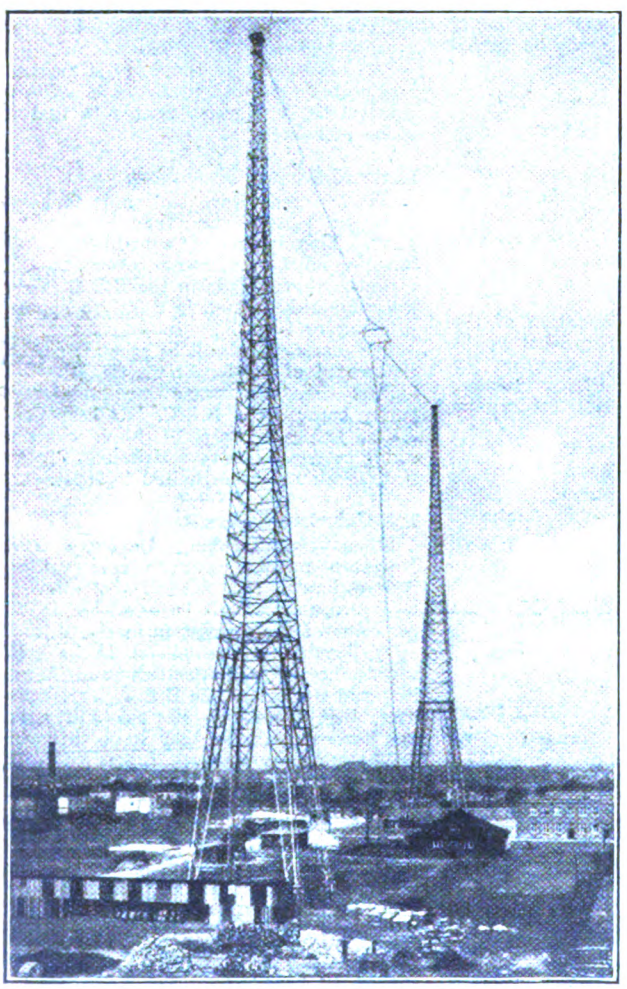
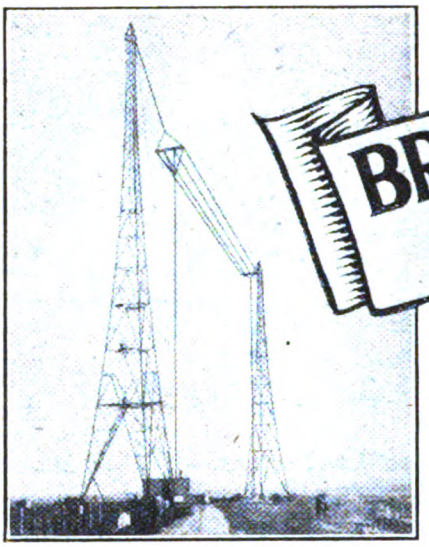
Station.	Kilowatts in Aerial.	Frequency in Kilocycles.	Wavelength in Metres.	Dial Settings.
Kovno (RYK) ..... Lithuania	7	155	**1935**	.....
Huizen ..... Holland	6.5	160	**1875**	.....
Lahti ..... Finland	40	167	**1796.4**	.....
Radio Paris ..... France	12	174	**1724.1**	.....
Zeesen ..... Germany	26	183.5	**1634.9**	.....
Daventry (5XX) ... Gt. Britain	25	193	**1554.4**	.....
Moscow (Komitern) .... Russia	12	202.5	**1481.5**	.....
Eiffel Tower (FL) ..... France	12	207.5	**1445.8**	.....
Warsaw ..... Poland	12	212.5	**1411.8**	.....
Motala ..... Sweden	30	222.5	**1348.3**	.....
Kharkov ..... Russia	4	230	**1304.3**	.....
Boden ..... Sweden	0.6	250	**1200**	.....
Reykjavik (*a*) ..... Iceland	5–7	250	**1200**	.....
Stamboul ..... Turkey	5	250	**1200**	.....
Kalundborg ..... Denmark	7.5	260	**1153.8**	.....
Hilversum (*b*) ..... Holland	6.5	280	**1071.4**	.....
Trondjhem (*a*) ..... Norway	1.2	280	**1071.4**	.....
Basle ..... Switzerland	0.25	297	**1010.1**	.....



General view of the Hamburg Station (Germany).



Kalundborg (Denmark).

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Explanatory Notes to the Ital at the

Station.	Kilowatts in Aerial.	Frequency in Kilocycles.	Wavelength in Metres.	Dial Settings.
Leningrad ..... Russia	20	300	**1000**	.....
Moscow (CCSP) ..... Russia	2	320	**937.5**	.....
Moscow ..... Russia	—	364	**824.2**	.....
Kiev (RA5) ..... Russia	1.2	375	**800**	.....
Petrozavodsk ..... Russia	2	385	**779.2**	.....
Ostersund ..... Sweden	0.6	389	**770**	.....
Radio Geneva .... Switzerland	0.25	395	**759.5**	.....
Minsk ..... Russia	4	428	**700**	.....
Lausanne ..... Switzerland	0.6	442	**678.7**	.....
Freiburg ..... Germany	0.25	527	**569.3**	.....
Hamar ..... Norway	0.7	527	**569.3**	.....
Ljubljana ..... Yugoslavia	3	527	**569.3**	.....
Smolensk ..... Russia	2	531.5	**564.4**	.....
Augsburg ..... Germany	0.25	536	**559.7**	.....
Hanover ..... Germany	0.25	536	**559.7**	.....
Budapest (HAL) ..... Hungary	15–20	545	**550.5**	.....
Sundsvall (SBD) ..... Sweden	0.6	554	**541.5**	.....
Munich ..... Germany	1.5	563	**532.9**	.....
Riga ..... Latvia	5	572	**524.5**	.....
Vienna (Rosenhügel) ... Austria	15	581	**516.4**	.....
Archangel ..... Russia	1.2	585.5	**512.4**	.....
Brussels ..... Belgium	1	590	**508.5**	.....
Milan ..... Italy	7	599	**500.8**	.....
Moscow ..... Russia	1.2	603.5	**497.1**	.....
Oslo (*c*) ..... Norway	1.2	608	**493.4**	.....
Prague (*c*) .... Czechoslovakia	5	617	**486.2**	.....
Gomel ..... Russia	1.2	621.5	**482.7**	.....
Daventry (5GB) ... Gt. Britain	25	626	**479.2**	.....
Simferopol ..... Russia	1.2	630	**476.4**	.....
Langenberg ..... Germany	15	635	**472.4**	.....
Lyon la Doua ..... France	5	644	**465.8**	.....
Zürich ..... Switzerland	0.63	653	**459.4**	.....
Aix-la-Chapelle ..... Germany	0.25	662	**453.1**	.....
Aalesund ..... Norway	0.3	662	**453.1**	.....
Bolzano ..... Italy	0.2	662	**453.1**	.....
Danzig ..... Danzig	0.25	662	**453.1**	.....

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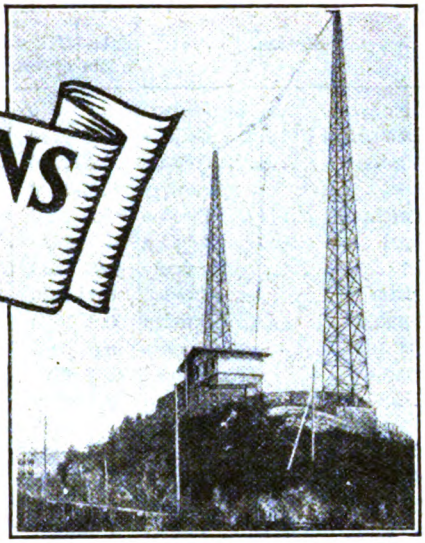
San Sebastian (Spain).

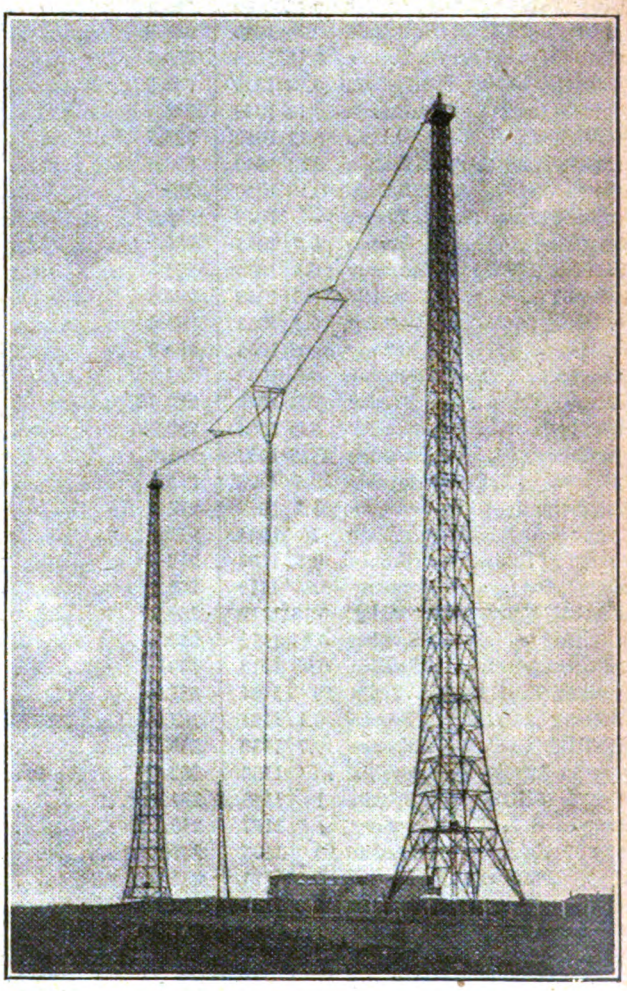


...T STATIONS ...UROPE

...er of Wavelengths.

References (a) to (k) will be found ...d of the lists.

Station.	Kilowatts in Aerial.	Frequency in Kilocycles.	Wavelength in Metres.	Dial Settings.
Klagenfurt ..... Austria	0.5	662	**453.1**	.....
Porsgrund ..... Norway	0.7	662	**453.1**	.....
Salamanca ..... Spain	1	662	**453.1**	.....
Tromsoe ..... Norway	0.1	662	**453.1**	.....
Tammerfors ..... Finland	0.8	662	**453.1**	.....
Upsala ..... Sweden	0.15	662	**453.1**	.....
Moscow (SP) ..... Russia	1	666.5	**450.1**	.....
Paris (Ecole Sup're) .... France	0.8	671	**447.1**	.....
Rjukan ..... Norway	0.15	671	**447.1**	.....
Rome (1RO) ..... Italy	3	680	**441.2**	.....
Stockholm (*e*) ..... Sweden	1	689	**435.4**	.....
Malmberget ..... Sweden	0.25	689	**435.4**	.....
Belgrade ..... Yugoslavia	2.5	698	**429.8**	.....
Kharkov ..... Russia	4	702.5	**427**	.....
Madrid (EAJ7) ..... Spain	2	707	**424.3**	.....
Berlin (Witzleben) .... Germany	1.5	716	**419**	.....
Dublin (2RN) ..... Irish F.S.	1	725	**413.8**	.....
Rabat ..... Morocco	10	727	**412**	.....
Odessa ..... Russia	1.2	729.5	**411.2**	.....
Katowitz ..... Poland	10	734	**408.7**	.....
Berne ..... Switzerland	1.2	743	**403.8**	.....
Koursk ..... Russia	1.2	747.5	**401.3**	.....
Glasgow (5SC) ..... Gt. Britain	1	752	**398.9**	.....
Bucarest ..... Roumania	12	761	**394.2**	.....
Fredriksstad ..... Norway	0.7	761	**394.2**	.....
Frankfurt-on-Main ... Germany	1.5	770	**389.6**	.....
Wilno ..... Poland	0.5	779	**385.1**	.....
Genoa ..... Italy	1.2	779	**385.1**	.....
Dnepropetrovsk ..... Russia	1.2	783.5	**382.9**	.....
Radio Toulouse ..... France	8	788	**380.7**	.....
Artemovsk ..... Russia	1.2	792.5	**378.5**	.....
Manchester (2ZY) .. Gt. Britain	1	797	**376.4**	.....
Hamburg ..... Germany	1.5	806	**372.2**	.....
Tver ..... Russia	1	810	**370.1**	.....
Paris (LL) ..... France	1.5	815	**368.1**	.....
Seville (EAJ5) ..... Spain	1.5	815	**368.1**	.....
San Sebastian (EAJ8) ... Spain	0.3	815	**368.1**	.....
Nikolaiev ..... Russia	1.2	819.5	**366.1**	.....
Bergen ..... Norway	1	824	**364.1**	.....
Stuttgart ..... Germany	1.5	833	**360.1**	.....
London (2LO) ..... Gt. Britain	30	842	**356.3**	.....
Graz ..... Austria	7	851	**352.5**	.....
Algiers ..... Algeria	—	852.6	**351**	.....
Leningrad ..... Russia	1.2	855.5	**350.7**	.....
Barcelona (EAJ1) ..... Spain	8	860	**348.8**	.....
Brunn (*d*) ..... Czechoslovakia	2.4	878	**341.7**	.....
Bremen (*c*) ..... Germany	0.25	887	**338.2**	.....
Brussels (No. 2) (*f*) ... Belgium	2	887	**338.2**	.....
Ivan-Vornesensk ..... Russia	1.2	891.5	**336.5**	.....
Cadiz ..... Spain	0.55	895	**335**	.....
Posen ..... Poland	1.2	896	**334.8**	.....
Naples (1NA) ..... Italy	1.5	905	**331.4**	.....
Paris (Petit Parisien) ... France	0.8	905	**331.4**	.....
Grenoble (PTT) ..... France	—	914	**328.2**	.....



The masts and aerial system at Stuttgart (Germany).

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Station.	Kilo-watts	Kilo-cycles.	Wave-length.	Dial Settings.
Breslau ..... Germany	1.5	923	**325**	.....
Falun ..... Sweden	2	932	**321.9**	.....
Göteborg ..... Sweden	10	932	**321.9**	.....
Dresden (*e*) ..... Germany	0.25	941	**318.8**	.....
Marseilles (PTT) ..... France	0.5	950	**315.8**	.....
Oviedo ..... Spain	0.7	955.4	**314**	.....
Cracow ..... Poland	1	959	**313**	.....
Cardiff (5WA) ..... Gt. Britain	1	968	**309.9**	.....
Paris(Vitus) ..... France	1	973	**308**	.....
Zagreb ..... Yugoslavia	0.7	973	**308**	.....
Agen ..... France	0.5	981.7	**305.6**	.....
Bordeaux-Lafayette .... France	1	986	**304.3**	.....
Aberdeen (2BD).... Gt. Britain	1	995	**301**	.....
Hilversum (*g*) ..... Holland	6.5	1004	**298.8**	.....
Tallinn ..... Esthonia	1.5	1013	**296**	.....
Kosice ..... Czechoslovakia	2	1022	**293.6**	.....
Limoges ..... France	0.5	1022	**293.6**	.....
Lyons ..... France	0.5	1029.3	**291.4**	.....
Viborg ..... Finland	0.4	1031	**291**	.....
Bournemouth (6BM) Gt. Britain	1	1040	**288.5**	.....
Bradford (2LS)..... Gt. Britain	0.13	1040	**288.5**	.....
Dundee (2DE) ..... Gt. Britain	0.13	1040	**288.5**	.....
Edinburgh (2EH) .. Gt. Britain	0.35	1040	**288.5**	.....
Hull (6KH) ..... Gt. Britain	0.13	1040	**288.5**	.....
Liverpool (6LV) ... Gt. Britain	0.13	1040	**288.5**	.....
Plymouth (5PY) ... Gt. Britain	0.13	1040	**288.5**	.....
Sheffield (6FL) .... Gt. Britain	0.13	1040	**288.5**	.....
Stoke-on-Trent (6ST) Gt. Britain	0.13	1040	**288.5**	.....
Swansea (5SX)..... Gt. Britain	0.13	1040	**288.5**	.....
Mont-de-Marsan ..... France	—	1040	**288.5**	.....
Montpellier ..... France	0.2	1049	**286**	.....
Berlin No. 2 (*e*) ..... Germany	0.5	1058	**283.6**	.....
Innsbruck (*e*, *h*) ..... Austria	0.5	1058	**283.6**	.....
Magdeburg (*e*) ..... Germany	0.5	1058	**283.6**	.....
Notodden (*e*) ..... Norway	0.05	1058	**283.6**	.....
Stettin (*e*) ..... Germany	0.5	1058	**283.6**	.....
Uddevalla (*e*) ..... Sweden	0.05	1058	**283.6**	.....
Varberg (*e*) ..... Sweden	0.3	1058	**283.6**	.....
Copenhagen ..... Denmark	0.75	1067	**281.2**	.....
Bratislava .... Czechoslovakia	12.5	1076	**278.8**	.....
Königsberg ..... Germany	1.5	1085	**276.5**	.....
Turin ..... Italy	7	1094	**273.2**	.....
Rennes (PTT) ..... France	0.5	1103	**272**	.....
Kaiserslauten (*e*) ..... Germany	0.25	1112	**269.8**	.....
Hudiksvall (*e*)..... Sweden	0.15	1112	**269.8**	.....
Norrköping (*e*) ..... Sweden	0.25	1112	**269.8**	.....
Trollhätten (*e*) ..... Sweden	0.25	1112	**269.8**	.....
Barcelona (EAJ13) (*i*) ... Spain	10	1121	**267.6**	.....
Strasbourg ..... France	0.1	1121	**267.6**	.....
Lille (PTT) ..... France	0.7	1130	**265.5**	.....
Moravska-Ostrava C'choslovakia	10	1139	**263.4**	.....
Newcastle (5NO) ... Gt. Britain	1	1148	**261.3**	.....
Leipzig ..... Germany	1.5	1157	**259.3**	.....
Horby ..... Sweden	10	1166	**257.3**	.....
Toulouse (PTT) ..... France	1.2	1175	**255.3**	.....
Gleiwitz ..... Germany	5	1184	**253.4**	.....
Almeria (EAJ18) ..... Spain	1	1193	**251.5**	.....
Prague (No. 2). Czechoslovakia	—	1202	**249.6**	.....
Trieste ..... Italy	—	1211	**247.7**	.....
Abo ..... Finland	0.5	1220	**245.9**	.....
Bloemendael (*j*) ..... Holland	0.01	1220	**245.9**	.....
Cartagena ..... Spain	0.4	1220	**245.9**	.....
Cassel ..... Germany	0.25	1220	**245.9**	.....
Eskilstuna..... Sweden	0.2	1220	**245.9**	.....
Ghent ..... Belgium	—	1220	**245.9**	.....
Kiel ..... Germany	0.25	1220	**245.9**	.....
Kalmar ..... Sweden	0.2	1220	**245.9**	.....
Kiruna ..... Sweden	0.2	1220	**245.9**	.....
Linz ..... Austria	0.5	1220	**245.9**	.....
Pietarsaari ..... Finland	0.25	1220	**245.9**	.....
Säffle ..... Sweden	0.4	1220	**245.9**	.....
Schaerbeek ..... Belgium	—	1220	**245.9**	.....
Cracow ..... Poland	1	1229	**244.1**	.....
Belfast (2BE) ..... Gt. Britain	1	1238	**242.3**	.....
Rjukan ..... Norway	0.2	1247	**240.6**	.....
Nimes ..... France	1	1256	**238.9**	.....
Nurnberg..... Germany	2	1256	**238.9**	.....
Bordeaux (S-O) ..... France	—	1260	**238**	.....
Juan-les-Pins (Nice) (*i*).. France	—	1265	**237**	.....
Orebro ..... Sweden	0.2	1265	**237**	.....
Münster (*e*) ..... Germany	0.5	1283	**233.8**	.....
Lodz ..... Poland	—	1283	**233.8**	.....
Boras ..... Sweden	0.15	1301	**230.6**	.....
Hälsingborg ..... Sweden	0.2	1301	**230.6**	.....
Malmö ..... Sweden	0.6	1301	**230.6**	.....
Umea..... Sweden	0.2	1301	**230.6**	.....
Biarritz ..... France	1.5	1313	**228.4**	.....
Cologne ..... Germany	1.5	1319	**227.4**	.....
Bucarest Univ. (*e*) .. Roumania	—	1328	**225.9**	.....
Cork (6CK) ..... Irish F.S.	1	1337	**224.4**	.....
Luxembourg (*k*) . Luxembourg	3	1346	**222.9**	.....
Helsingfors ..... Finland	0.9	1355	**221.4**	.....
Fécamp ..... France	—	1354	**219.9**	.....
Flensburg ..... Germany	0.5	1373	**218.5**	.....
Karlstad ..... Sweden	0.25	1373	**218.5**	.....
Ornsköldsvik ..... Sweden	0.2	1373	**218.5**	.....
Bjorneborg ..... Finland	0.8	1373	**218.5**	.....
Halmstad ..... Sweden	0.2	1391	**216**	.....
Warsaw (No. 2) ..... Poland	—	1400	**214**	.....
Palermo (*l*) ..... Italy	—	1410	**212.8**	.....
Jassy Univ. (*e*)..... Roumania	—	1420	**211.3**	.....
Beziers ..... France	—	1420	**211.3**	.....
Gävle ..... Sweden	0.2	1470	**204**	.....
Kristinehamn ..... Sweden	0.25	1480	**202.7**	.....
Jönköping ..... Sweden	0.25	1490	**201.3**	.....
Leeds (2LS) (*e*)..... Gt. Britain	0.13	1500	**200**	.....
Karlskrona ..... Sweden	0.2	1530	**196**	.....

(*a*) = Projected.
(*b*) = After 6.0 p.m
(*c*) = Power to be increased to 60 kW.
(*d*) = Power to be increased to 35 kW.
(*e*) = Provisionally.
(*f*) = Under construction.
(*g*) = After 6.0 p.m.
(*h*) = Will work on 213 metres if 283 metres prove unsatisfactory.
(*i*) = Temporarily closed.
(*j*) = Sundays only.
(*k*) = Experimental.

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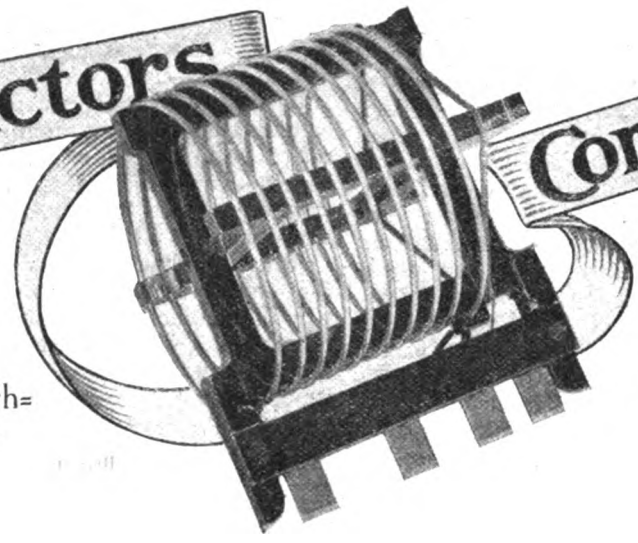
Radio Conductors Compared



How Electro-plating Affects High-frequency Resistance.

By W. H. F. GRIFFITHS, F.Inst.P., A.M.I.E.E.

AT the Radio Exhibition at Olympia the author noticed a display of low-loss inductance coils. They were of bright bare copper wire. A few of them were beautifully brightly finished—apparently silver-plated—but a notice in bold type proudly informed the enquiring visitor that "All coils are nickel-plated for short-wave work." The manufacturer had evidently seen such coils silver-plated and had made his coils bright also, but had forgotten not only that nickel is vastly inferior to silver, ordinarily, as a conductor, but also that it has para-magnetic properties which preclude its indiscriminate use at radio frequencies.

Although the average wireless amateur of to-day fully realises that "all is not gold that glitters," it is thought that a little information on the relative behaviour, at radio frequencies, of various conductors and the effect of electro-plating them with various other metals will be helpful to many, especially if expressed quantitatively. There are quite a number of simple problems encountered which demand a knowledge of radio-frequency conductivity.

Tinned Copper Wire.

Although at wavelengths round about 30 metres the resistance of a copper wire is increased from six to eight times its original value by nickel-plating it to a thickness of a few ten-thousandths of an inch only, tinning the same wire with a similar coating will only produce a 30 per cent. increase in its resistance, although the specific resistance of nickel and tin are of the same value. Many regard commercial tinned copper wire with the utmost suspicion and will not employ it despite the fact that soldering is greatly facilitated by its use. It can be stated, however, that the thickness of tin on the surface of this wire is such that it does not affect appreciably the resistance on wavelengths higher than 100 metres.[1] It is hoped that the comfort they derive from this statement will more than compensate for the shock of the blow to one of their pet theories.

Another interesting example of the importance of the knowledge of radio-frequency conductivity is that of the relative conductivity of copper and silver. It is generally supposed that silver is a much better conductor than copper, but even for direct current it is only about 6 per cent. better. At high radio-frequencies, on all but the finest wires, this advantage is reduced to 3 per cent. —there being virtually no difference between the two metals. This also, of course, applies equally to the relative effectiveness of copper- and silver-plating of conductors. A little greater advantage may be gained in the case of silver-plating copper coils due to the fact that the silver deposited is pure electrolytic metal, whereas the copper is hard-drawn and consequently impure. In this connection it may be of interest to note that the high-frequency resistance of a hard-drawn copper conductor is reduced by 2 per cent. or 3 per cent. by copper-plating.

Again, the difference in the conductivities of copper and aluminium is reduced at high frequencies. At ordinary frequencies aluminium is about 70 per cent. higher in resistance than copper, whereas at radio-frequencies a 30 per cent. increase only is produced by the substitution of the lighter metal. This fact combined with its low specific gravity makes aluminium suitable for such conductors as plates for variable condensers.

Just one other instance of the reduction in the resistance[2] of the higher specific resistance conductors at high radio-frequencies is to be found in the choice of aerial wire. A glance at any wire tables will show that phosphor-bronze has a D.C. resistance of five times that of copper, an increase which would make its use as an aerial a matter for serious consideration. At high radio-frequencies, however, this ratio is reduced to a little more than 2 to 1, and so the alloy (which has the advantage of a much greater tensile strength and much lower ductility than copper) may be employed without the introduction of serious loss in the aerial.

[1] Even at 30 metres the increase of resistance due to the tin may be only 5 per cent., and it is thus seen that the effect is almost negligible on all but the lowest wavelengths.

[2] In comparison with copper.

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Radio Conductors Compared.—

High-frequency Resistance due to "Skin Effect."

It will be noticed from the figures of the above examples that the ratio of high-frequency resistances of two conductors is always approximately proportional to the *square root* of the ratio of their specific resistances.[3] This is because of the well-known "skin effect" of radio-frequency current conduction. The current which flows in a conductor at radio-frequencies only "flows" in the outer crust or "skin," and its value is therefore limited (or the resistance increased) by this restriction of area. Under these conditions the resistance of the conductor, or the current it will pass, will not be materially changed if the centre of the conductor is cut away, leaving only the crust or skin in the form of a tube. The amount which could be cut from the centre without affecting the value of current passing at any particular frequency is a measure of the increase of resistance of the solid wire, at that frequency, above its D.C. value.

In order to be used as a criterion of resistance increase in this way the amount of this superfluous "core" should be expressed as a percentage of the total cross-sectional area of the solid conductor. The percentage will be greater for higher frequencies and for conductors of greater cross-section.

[3] This is only true for conductors having unity magnetic permeability, as will be explained later.

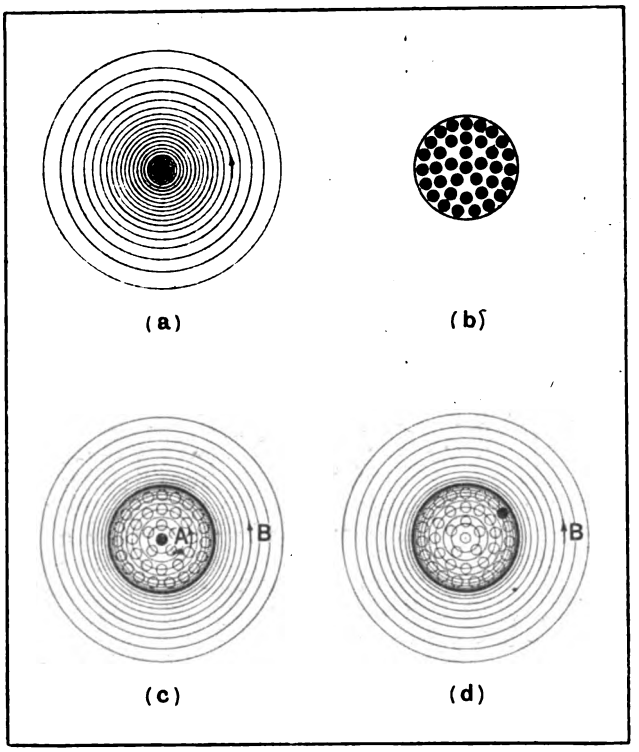

Fig. 1.—Illustrating skin-effect. (a) An alternating field of circular magnetic lines around a thin wire. (b) To explain the skin effect, a solid conductor can be considered as composed of a number of fine wires. (c) A fine wire at the centre of the conductor will have a field A inside the conductor and a field B outside. (d) A wire near the skin of the conductor will only have the field B linking with it.

A Simple Explanation of "Skin Effect."

In order to form some idea of the reason for this "surface flow" of high-frequency current, it is well to consider a conductor of circular cross-section and of large diameter—a copper rod. The reader will, of course, know that an alternating magnetic field is produced by an alternating current flowing in a thin wire—he will know also that this field takes the form of circular magnetic "lines" round the thin wire and concentric with it as shown in Fig. 1(a). This field, by virtue of the fact that it is linked with the current producing it, gives the conductor inductance L (even if it is a straight wire) an inductance which, at very high frequencies, gives to the wire a reactance (ωL) sufficiently high to limit the current flow as seriously as or sometimes more seriously than its resistance.

Now let a large-diameter copper rod be considered to be built up of a number of thin copper wires, say 1,000, of equal diameter, and packed tightly as shown in Fig. 1(b). If the conductor forms part of a D.C. or low-frequency A.C. circuit, each wire will conduct its proper $\frac{1}{1000}$ part of the total current carried by the complete conductor; the current through each wire being limited only by its resistance. If this composite conductor is made to form part of a radio-frequency circuit, however, the reactance of each of these fine wires becomes sufficiently high to share with its resistance in limiting the current flowing in it because reactance ($2\pi fL$) is proportional to frequency (f). The reactance of each fine wire is also proportional to its inductance (L) which is in turn proportional to the quantity of magnetic flux (or field) surrounding it.

It is obvious that a fine wire in the centre of the conductor shown in Fig. 1(c) will have surrounding it the magnetic field A inside the conductor as well as that of B on the outside. A wire on the outer skin of the conductor such as that of Fig. 1(d) will, on the other hand, have only the field B outside the conductor linking with it. It is easy to see, therefore, that the innermost thin wires will have a greater inductance than those near the surface. The current flowing in these innermost wires will therefore be less than that in the outer wires because of its greater limitation by their greater inductance and reactance. By this reasoning a simple idea of skin effect may be formed.

Properties of Iron and Nickel Wire.

Stated correctly, the current density rapidly diminishes towards the centre of the conductor, and in large-diameter conductors there is actually no current at all flowing in the centre of the wire at high frequencies. As one would expect, if the conductor is of high specific resistance then the diminution of current density towards the centre of the wire is less rapid, i.e., the "skin depth" to which the high-frequency current penetrates increases as the specific resistance of the conducting metal increases—as the square root of f as a matter of fact. The skin effect is less, due to the fact that the limitation of current by reactance is less important because the ratio of reactance to resistance is less due to the higher resistance.

There is obviously another property of the conductor which influences the skin depth—that of magnetic per-

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Radio Conductors Compared.—

meability. Unless the conductor be of a para-magnetic material, such as iron, steel or nickel, its skin depth will depend (for a given frequency) entirely upon its specific resistance, since the permeability will be unity. But if the conductor be of one of the above-mentioned

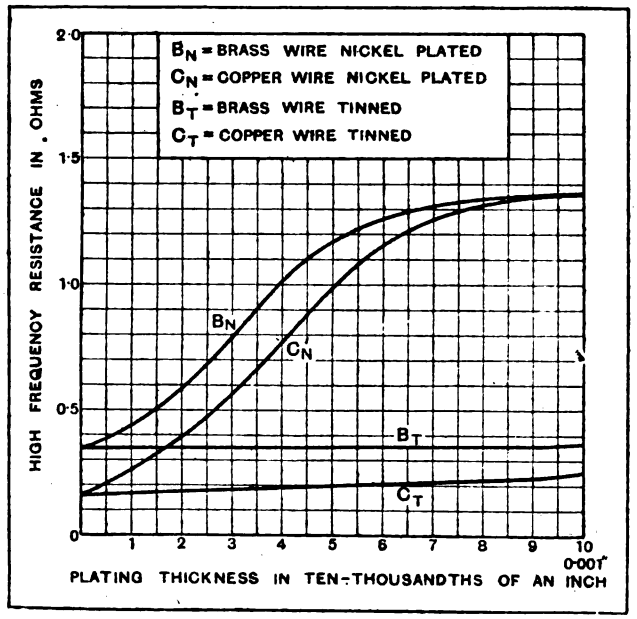

Fig. 2.—Curves showing the increase of resistance (at 30 metres) of brass and copper wires due to nickel-plating or tinning to various thicknesses. The wires were one yard lengths of 16 S.W.G. B_N is brass wire nickel-plated; C_N, copper wire nickel-plated; B_T, brass wire tinned, and C_T copper wire tinned.

magnetic metals, the skin depth to which high-frequency current will penetrate will be very much less. The reason for this is easily appreciated, because the magnetic field density inside the conductor will be much greater than that outside—greater by the value of the permeability of the conductor of course. This, in turn, causes a greatly increased magnetic linkage (inductance) at the centre of the conductor, or even at portions only just below the surface. It is due to this cause that the skin depth of a conductor, at a given frequency, is inversely proportional to the square root of the permeability of that conductor.

The Electro-plating of Conductors.

Thus it is seen that specific resistance is of less importance in radio-frequency conductors than in ordinary electrical circuits, but that iron, steel and nickel are to be avoided. Moreover, since the current at high radio-frequencies only penetrates into the skin of a conductor, it is obvious that in the case of electro-plated conductors it is the metal with which they are plated that determines largely the skin depth and resistance.

Wires of low resistance, such as copper, are rendered much less conducting by plating with high-resistance and permeable metals, such as nickel, and wires of high resistance and permeability are rendered much more conducting by plating with, say, copper. For short-wave circuits copper or brass parts and wires should never be nickel-plated for the purpose of finish unless the thickness of plating can be ascertained with accuracy. Copper or brass parts may be tinned, however, without greatly affecting their high-frequency resistance.

In Fig. 2 is shown the increase in resistance of one yard of 16 S.W.G. brass and copper wire, due to nickel-plating and tinning, to various thicknesses up to 1 mil. The measurements were effected at 10,000 kilocycles (30 metres), and the curves show well the great difference between the skin effect of tin and nickel, a difference which is practically wholly due to the para-magnetic properties of the latter, because the two metals are of roughly the same specific resistance.

A Costly Decimal Point.

The question of finish for short-wave coils of bare copper wire or braid always calls for much consideration, more especially as this has often to be done after the coil has been completed on its insulating former. Copper, if left exposed to the atmosphere, will tarnish very quickly. Lacquer cannot be applied readily after winding. Gilding the wire or braid prior to winding provides a very effective and enduring finish, but the specific resistance of gold is appreciably greater than that of copper, and the gold-plating thickness must, in consequence of this, be kept very thin.

For another reason—obviously that of cost—the quantity of gold deposited during gilding must be kept less than, say, one ten-thousandth of an inch. The author had occasion recently to have gilded some copper braid for short-wave coils, and through a misunderstanding, which amounted to the incorrect position of a

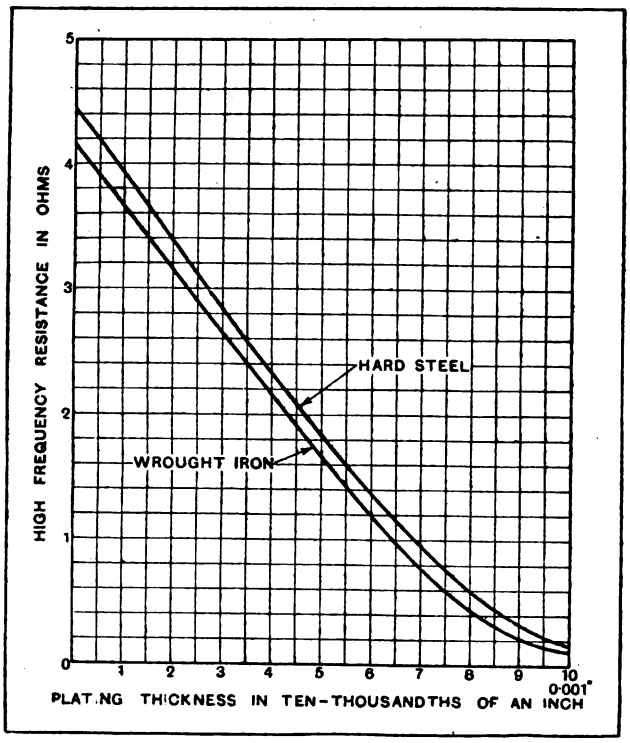

Fig. 3.—Curves showing the great reduction which is effected in the resistance of iron and steel wires at 30 metres by electro-plating them with various thicknesses of copper. The wires were one yard lengths of 16 S.W.G.

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Radio Conductors Compared.—

decimal point, the thickness of gold deposited was <0.001 inch, instead of <0.0001 inch.

A costly monument has thus been erected to remind those responsible of the effect of too heavily plating high-frequency copper conductors, for there is no use to which yards of heavily gold-plated braid can be put. Not only was the cost of gilding prohibitive, but the thickness of gold was sufficient to cause an increase of resistance greater than could be permitted in the coils of which the lowest possible power-factor was an essential quality.

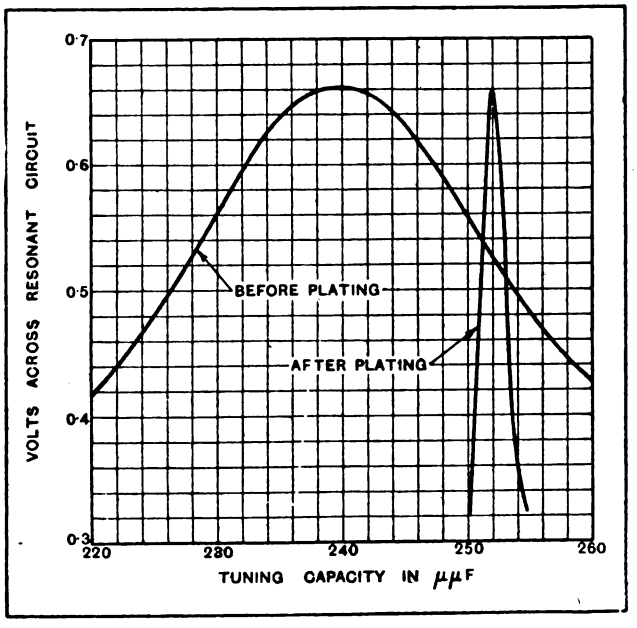

Fig. 4.—These experimentally obtained resonance curves show the extent to which the tuning of a single turn loop of 16 S.W.G. wrought iron wire is sharpened at 30 metres by electro-plating it with one-thousandth of an inch of copper. One yard of the wire was bent into a 9 in. diameter loop (with parallel ends) and tuned by a variable condenser of the capacity indicated.

The Use of Steel Wires as Conductors.

Iron, steel and nickel wires are tremendously reduced in resistance at high radio frequencies by a thin coating of copper. In Fig 3 is shown the reduction of resistance of a yard of 16 S.W.G. wrought iron and hard piano steel wire at 30 metres by copper-ylating to various thicknesses up to 1 mil., the approximate skin depth for copper at this frequency. The reduction of resistance effected by one thousandth of an inch of copper on the wrought iron wire is seen to be about 27 to 1, and the effect of such a reduction upon the tuning sharpness of a resonant circuit is shown by the comparative resonance curves of Fig. 4 for a circuit formed with this wire before and after plating. The length of wire was merely bent into a 9in. diameter loop and tuned by a variable condenser of about 240 $\mu\mu$F. at 30 metres. From Fig. 3 it is seen that with only one-thousandth of an inch of copper-plating on the iron and steel wires their resistances are reduced to the values of the solid copper wire of Fig. 2, proving that the skin depth of copper at 30 metres is of the order 0.001 inch. Where great rigidity or mechanical strength is desirable, it is thus possible to use steel wires as portions of radio-frequency circuits, providing they are thinly coated with copper.

CLUB NEWS.

New Society for Sevenoaks.

A Radio Society is now being formed in Sevenoaks. Readers of *The Wireless World* residing in that neighbourhood can obtain full particulars from Mr. E. M. Dent, Cornwall Lodge, Dunton Green, who is acting secretary (pro. tem.) or from Mr. R. Bernard, 42, High Street, Sevenoaks.

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At the Broadcasting End.

"The Maintenance of a Modern Broadcast Station" is the title of a lecture to be given by Mr. Noel D. Cumming at a meeting of the Institute of Wireless Technology to be held at 7 p.m. on Nov. 11th at the Engineers' Club, Coventry St., London, W. Those interested in the activities of the Institute should communicate with the Hon. Secretary, Mr. H. J. King, 71, Kingsway, London, W.C.2.

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Home-constructed Loud Speakers.

Several loud speakers of the linen diaphragm type constructed by members were demonstrated and compared at a well-attended meeting of the Southend-on-Sea and District Radio Society on October 18th. The tests were conducted by means of gramophone pick-up and radio reception. The two best, in the opinion of those present, were described by their constructors.

Hon. Secretary, Mr. F. J. Walker, Lynthorpe, Grange Gardens, Southend-on-Sea.

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Selectivity Problem in North London.

Now that Brookmans Park is transmitting the whole of the London programmes, listeners in the area covered by the Tottenham Wireless Society are experiencing difficulty in receiving the alternative programme from Daventry 5GB. In a topical lecture on "Selectivity and the Brookmans Park Transmissions" at the Society's last meeting, Mr. F. E. R. Neale gave valuable hints on improving selectivity and provided the theme for a rousing discussion. The lecturer condemned the use of a wave trap, although such a device would cut out all trace of the present transmissions. Within the next few months a second programme would be transmitted from Brookmans Park at a similar strength and a wave trap would be unable to cope with two such transmissions. The methods which the lecturer had found effective in this locality were the use of an ordinary loose coupled circuit with tuned aerial and secondary, and coil reaction, if used, operating on the secondary, or the employment of an extra tuned circuit, the aerial side of which was coupled to the aerial terminal of the set by a small neutrodyne condenser.

Hon. Secretary, Mr. R. C. A. Haynes, 159, Lordship Lane, N.22.

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Ilford and District Radio Society.

Wireless enthusiasts in the Ilford district who decide to join the Ilford and District Radio Society will be assured of a good programme during the coming months. A cinematograph lecture was given on October 24th by Messrs. Siemens Bros., the subject being Lamps, Batteries and Cables. A lecture on "Operation from A.C. Mains" will be contributed by the Marconiphone Co., Ltd., on December 5th.

Hon. Secretary, Mr. C. E. Largen, 16, Clements Road, Ilford.

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Television Explained.

"The Principles of Television" was the subject of a lecture given by Mr. J. Denton, A.M.I.E.E., at a meeting of the Muswell Hill and District Radio Society on October 23rd. By means of a very comprehensive series of lantern slides and some novel experiments with television apparatus members were able to gain an excellent insight into the work that had been accomplished in the television field.

Wireless enthusiasts in the district who are interested in the activities of the Society are invited to communicate with the Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road, N.10.

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New Society in Sheringham.

The Sheringham and District Wireless Society, which has just been formed, is already in a flourishing condition with a membership of 60, including a number of ladies. Vacancies for new members still exist, however, and full particulars can be obtained from the Hon. Secretary, Mr. C. R. Hunt, Kensington House, Church Street, Sheringham. Meetings are held weekly in the British Legion Rooms, Church Street.

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Battery Eliminators.

Battery eliminators, a topic of special interest at the present time, was the subject of a lecture by Mr. Ingham, of Messrs. H. Clarke and Co. (Manchester), Ltd., given recently before Slade Radio (Birmingham). The various circuits involved were carefully described, and members were able to inspect one of the latest types of eliminator.

The fourth whist drive and dance, held on October 23rd, was attended by over 120 people. Forthcoming items in the syllabus include a visit to the Central Telephone Exchange on November 16th, and a visit to one of the City Electric power stations in the near future.

Full details regarding the Society's activities can be obtained from the Hon. Secretary, "Enville," Warren Road, Erdington.

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A New Moving-Coil Loud Speaker.

The Celestion "Celestrola" moving-coil loud speaker was demonstrated at a recent meeting of the Bec (Streatham) Radio Society. The model exhibited had a field winding which could be energised by a low-tension voltage of from 6 to 12 volts. Satisfactory results were obtained using a 3-valve receiver with screened grid H.F. valve, detector and 4-volt Pentode.

An attractive syllabus has been arranged for the coming weeks, and any new members will be heartily welcome.

Hon. Secretary: Mr. A. L. Odell, 171, Tranmere Rd., S.W.18.

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CURRENT TOPICS

Events of the Week in Brief Review.

LOOK YOU !

For the first time in the history of the National Eisteddfod of Wales wireless is to be included among the competition subjects. At the Eisteddfod to be held at Llanelly in August, 1930, a prize of £3 will be offered for the best home-constructed wireless receiver costing not more than £10.

The factors governing the choice of the winner will be quality of reception, workmanship, and value for money.

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DUTCH APPARATUS FOR SIAM.

An order has been placed by the Siamese Government with the Philips Radio Co. of Eindhoven, Holland, for a twin wavelength broadcasting plant at Bangkok which will transmit on 300 and 30 metres simultaneously.

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S.A. TO OUTWIT "PIRATES."

The ordinary methods having failed, the South African Government has decided upon a drastic measure to secure adequate revenue for the broadcasting services. According to *South Africa*, the Government have in view the abolition of the present licence fees, substituting a 25 per cent. duty on the importation of all wireless goods. While the Government will retain 3 per cent., the balance will in all probability be handed over to the African Broadcasting Company.

It is felt that a system on these lines will not only popularise wireless, but compel the erstwhile "pirate" to contribute indirectly to the broadcasting service or give up listening altogether.

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"WIRED RADIO" CAMPAIGN IN U.S.

"Wired radio" will shortly be a household term in America if success attends the plans of the new Wired Radio Corporation which is about to launch its scheme publicly at the Cleveland Electrical Exhibition.

The company will there display for sale a small box-shaped attachment, containing a frequency filter, which can be attached to any existing radio receiver and permit its owner a choice of three programmes sent over the ordinary electric light wires by three-phase high-frequency transmitters.

One of the inducements offered to the listener is the absence of all advertising matter in the wired radio programmes; it is also pointed out that the transmissions will be completely free from atmospherics and other forms of disturbance.

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SHUT THE WINDOW.

Burgomaster Max of Brussels has formulated a new bylaw forbidding the use of loud speakers at open windows.

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"FIFTY YEARS OF ELECTRICAL SCIENCE."

At the inaugural meeting of a new session of the Royal Society of Arts to be held this evening (Wednesday) at 8.30 at John Street, Adelphi, London, W.C.2, the Chairman of the Council, Mr. Llewelyn B. Atkinson, M.I.E.E., will give an address entitled: "Fifty Years of Electrical Science and Industry."

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NEW RADIO NAVIGATION SCHEME.

A development of the principle of the radio beacon in a manner which would enable ships and aircraft to follow routes plotted out for them from hour to hour while *en route* is contained in an invention submitted to the French Academy of Sciences by M. Guillaume Loth.

The invention, which is endorsed by General Ferrié, head of the French Army's wireless services, makes use of intersecting beams of Hertzian waves. When a vessel is likely to enter a stormy area the beam angles can be altered to indicate the safest route.

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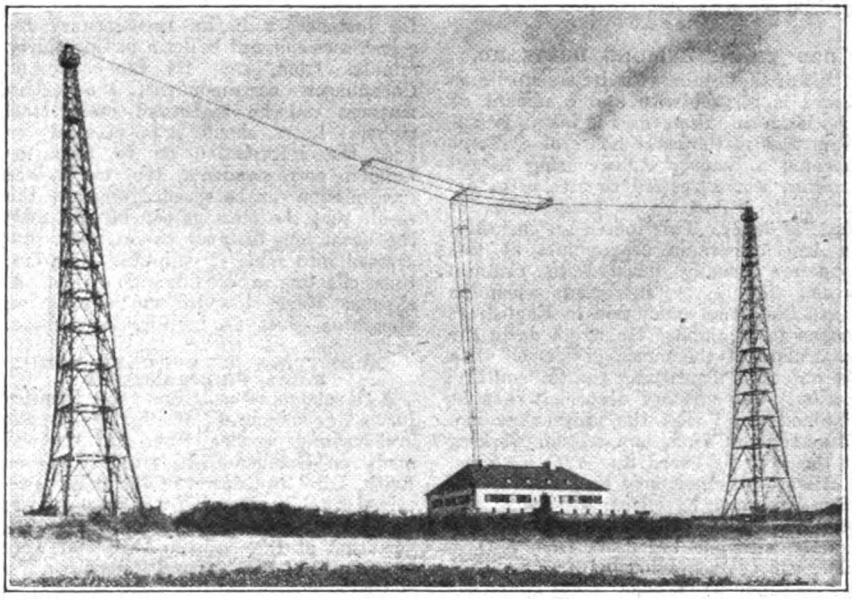
LISTENERS AND A GOVERNMENT STATION.

Last April, when annual wireless licences in Denmark expired, many listeners refused to renew their licences owing to the interference caused to broadcast reception from Copenhagen by the Government's own wireless telegraph and telephone station at Soro, which maintains a service between the mainland and the island of Bornholm. In response to the listeners' attitude, writes a correspondent, the Government has now decided to close down the Soro station and lay a cable to Bornholm.



A TYPICAL GERMAN RELAY STATION. Kaiserslautern, which relays a number of transmissions in turn, including those of Nuremberg, Augsburg and Munich. The common wavelength of 270 metres is used.

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PITY THE MAN UPSTAIRS.

A bylaw proposed by the Hornsey Town Council aims at prohibiting the use of loud speakers in wireless shops if disturbance is caused to neighbours or to persons living over the shop.

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LADY WINS SET-BUILDING PRIZE.

Miss C. Martaki has won the First Prize (25 guineas) in Class 2 of the set-building competition organised in connection with the recent Manchester Wireless Exhibition. In Miss Martaki's set, the best among receivers designed specially for quality reproduction, the whole tuning arrangement consisted of a 40-turn coil and a single .00035 condenser. The wiring was well spaced on a baseboard over a yard in length and 10½in. in width.

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AMERICAN RADIO MERGER.

The biggest radio merger yet planned in America is to become effective as from January 1st, 1930, when the Victor Talking Machine Co., the Radio Corporation, the Western Electric Co., and the General Electric Co. will combine in the production and sale of radio equipment.

The central manufacturing plant of the organisation will be situated at Camden, and will employ 26,000 men. The total sales are expected to reach £100,000,000 a year.

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SUNBEAMS IN AUSTRALIA.

Shareholders in the Amalgamated Wireless Company of Australia are praising Marquis Marconi for his invention of the beam, which has brought them dividend warrants for the first time. After an interval of twenty-one months, the company has published its balance sheets for the past two years. They show profits of £47,000 and £80,000, and dividends of 6 and 8 per cent. respectively. It is considered beyond doubt that the new beam services are responsible for the company's changed fortunes.

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OLD TRANSMISSIONS RE-HEARD.

One of the "tallest" wireless stories on record is related with a due amount of scepticism in *Time and Tide*. It appears that in the early hours of a recent morning a listener endeavouring to get America was surprised to receive at exceptional strength a programme of classical music. This roused his curiosity, as American radio programmes at this time are usually devoted to classical music, and it was increased when he heard the items announced in English as spoken in England. He wrote down the particulars of the music performed with the object of identifying the transmitting station. The mystery deepened when he obtained proof that the programme had not emanated from any station working at the hour he heard it.

His astonishment may be judged when, after what must have been a weary search, he discovered that the programme tallied exactly with one broadcast from 2LO in 1927, two years previously!

Here indeed was an echo from the depths of space which might well frighten the boldest. For how many programmes could we endure twice?

"SELECTIVITY AND QUALITY."

It is regretted that a typographical error occurred in the article bearing the above title in last week's issue. On page 479, column 2, line 21, the figure for side-band variation is given as 15 per cent., whereas the correct figure is 52 per cent. The figures for the same circuit are given correctly in the table.

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HIGH-SPEED SPEECH.

Dr. Curt Stille, a well-known German engineer, who for some considerable time has been at work on apparatus for the electro-magnetic registration of sounds, is reported to have constructed a Press talking machine, writes a correspondent.

When connected to an ordinary telephone instrument, the apparatus registers all incoming communications, which in their turn can be amplified and reproduced as required through a loud speaker. The main advantage of the invention, however, lies in the fact that it permits a species of high-speed telephony. If, for instance, a Berlin news agency receives a telephoned bulletin lasting thirty minutes from, say, its Stockholm or Copenhagen correspondent, the entire message can be registered on a steel ribbon. Later, should it be necessary to pass the information on to Paris or London correspondents, the mechanical transmission can be speeded up, with the result that the message can be sent over the usual long-distance cables, and compressed into some six minutes' duration, thus effecting a considerable saving in expense. When slowed down the receiving apparatus gives an intelligible message.

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ARGENTINA TELEPHONES FOR B.B.C. PROGRAMMES.

A telephonic appeal from the Argentine for a development of the short-wave broadcasting service from Britain was made on October 25th, when Sir John Reith, Director-General of the B.B.C., received a telephone call from Buenos Aires *via* Berlin. Those engaged in the conversation at the Buenos Aires end were Mr. Hirst, of the Marconi Company; Mr. Barbara, manager of the River Plate Telephone Company; and Mr. Brumen, head of the English Speaking Radio Club of Argentina.

Mr. Brumen stated that plans were going forward for a new broadcasting station near Buenos Aires to serve programmes in English to the 100,000 English-speaking people of Argentina. Britishers in the Argentine were keenly interested in 5SW and looked forward anxiously for an extension of its service.

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FREE LICENCES FOR SICK POOR.

The Reich Broadcasting Society has announced that licence fees are to be remitted in the case of sick persons with limited incomes. Free licences have already been available in Germany to blind listeners and War invalids.

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FORTHCOMING EVENTS.

WEDNESDAY, NOVEMBER 6th.

Institution of Electrical Engineers, Wireless Section.—At 6 p.m. At the Institution, Savoy Place, W.C.2. Inaugural Address by the chairman, Captain C. E. Kennedy-Purvis, R.N.

Muswell Hill and District Radio Society.—At 8 p.m. At Tollington School, Tetherdown, N.10. Lecture and Demonstration: "The Testing of the Modern Gramophone Pick-up," by Mr. F. N. G. Leevers.

Edinburgh and District Radio Society.—At 8 p.m. At the Royal Terrace. Query night.

THURSDAY, NOVEMBER 7th.

Ilford and District Radio Society.—At the Wesleyan Institute, High Road. Informal meeting. Junk Sale.

Slade Radio (Birmingham). At the Parochial Hall, Broomfield Road, Erdington. Talk on Electricity, by Mr. W. E. Chilvers. The Construction of S.G. Receiver Stage, by Mr. N. B. Simmonds.

TUESDAY, NOVEMBER 12th.

Ryde Radio Society.—At 8 p.m. At Mount House Hall, George Street, Ryde, I.O.W. Annual General Meeting.

BOOKS RECEIVED.

Telegraphy and Telephony, Including Wireless, by E. Mallett, D.Sc. (Eng.) London.—An introductory text-book to the science and art of the electrical communication of intelligence. Comprising line telegraphy for short and long lines; line telephony, including a chapter on manual and automatic exchanges; wireless telegraphy and telephony, and an appendix of mathematical formulæ and tables relating to the subjects dealt with. Pp. 413+ix with 287 diagrams and illustrations. Published by Chapman and Hall, Ltd., price 21s. net.

B.B.C. Year Book, 1930.—Including special articles on matters of broadcasting interest; events of the past year; the history of the old B.B.C. from November, 1922, to December, 1926; general articles on musical, educational, and dramatic broadcasting. Technical articles, tables and formulæ. Pp. 463 with numerous illustrations. Published by the British Broadcasting Corporation, London, price 2s.

Questions and Solutions in Magnetism and Electricity, by W. J. White, A.M.I.E.E. (Third Edition).—Consisting of the solutions to questions set by the Board of Education and City and Guilds of London Institute in Stage 1 of Magnetism and Electricity during the years 1907 to 1929. Pp. 178+32 with 97 diagrams. Published by Sir Isaac Pitman and Sons, Ltd., London, price 5s. net.

Wireless Transmission and Reception (Technical Pamphlets for Workmen, PW-C.1).—Revised edition, issued by the Post Office Engineering Department and comprising a brief summary of the general principles of wireless telegraphy, systems of generation and transmission (including telephony), reception, direction finding and instructions for the inspection of wireless stations by P.O. officers. Pp. 67, with 44 diagrams. Published by H.M. Stationery Office, price 6d. net.

Wireless Time Signals for the Use of Surveyors, by A. R. Hinks, C.B.E., M.A., F.R.S., Secretary R.G.S.—Comprising a list of the time signals transmitted from various stations in all parts of the world with introductory remarks on the nature of the signals and practical advice on their application to geographical surveys. Pp. 31, with map. Issued by the Royal Geographical Society and published by Edward Stanford, Ltd., London, price 3s.

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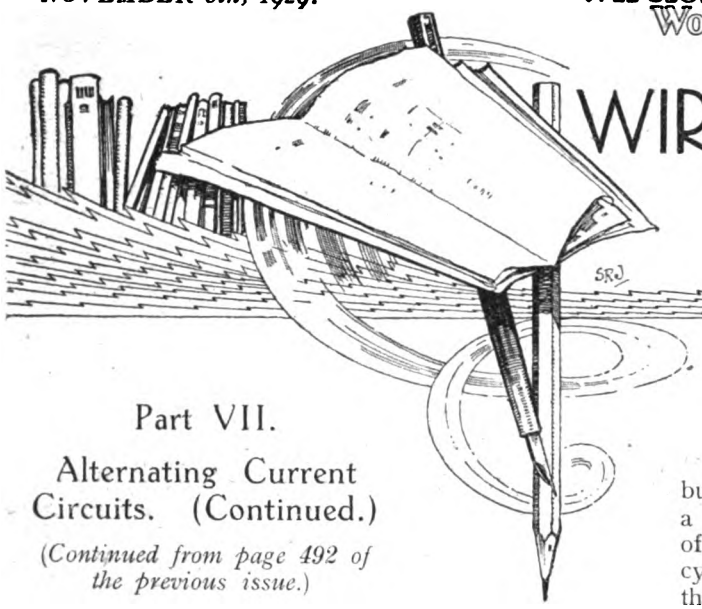

WIRELESS THEORY SIMPLIFIED

Part VII.

Alternating Current Circuits. (Continued.)

(*Continued from page 492 of the previous issue.*)

By S. O. PEARSON, B.Sc., A.M.I.E.E.

WHEN learning the elementary laws of electricity we are shown that the power in a D.C. circuit is given in watts by the product of current and electromotive force. Then later we learn that the same laws apply to an A.C. circuit containing resistance only (see Part VI, last issue). Now we encounter the apparent paradox that when an alternating current is passed through a coil possessing inductance only no power whatever is absorbed! At first this discovery is rather disconcerting, but after a little consideration the reasons become fairly obvious.

In the first place, no heat can be generated where there is no resistance—this is a fundamental law. And yet it is equally true that at any instant the power is actually equal to the product of current and voltage at that instant in any circuit. The question is: What is becoming of the energy represented by this power if it is not being converted into heat? The answer lies in the fact that energy is required to build up a magnetic field and that this energy is all recovered by the circuit when the field dies away again. We shall now deal with this point in some detail because a clear understanding of it will enable the reader to follow more easily the workings of oscillating circuits—one of the main subjects we are leading up to.

The Effect of Phase Difference on Power.

Although there is no such thing as a perfect choking coil, that is, one without any resistance whatever, this condition can be fairly closely approached in practice. As before, we shall assume that we have a coil whose inductance is L henrys and whose resistance is zero. It was shown that for such a coil the sine waves of voltage and current are exactly 90° out of phase (or in quadrature), the current lagging behind the applied voltage. The current and voltage curves are shown in their correct relative positions in Fig. 1.

Suppose that the maximum value reached by the current every half cycle is I_m amperes. Over the first quarter cycle from O to P in the diagram the current builds up from zero to I_m in the positive direction, and a magnetic field is established, linked with the turns of the coil. It will be seen that during this first quarter cycle the current and voltage are both positive and therefore that energy is being put into the circuit. This is absorbed by the growing magnetic field, and when the current has reached the maximum value I_m the stored energy will be $\frac{1}{2}LI^2$ joules or watt-seconds (see Part V). Now during the next quarter cycle, from P to Q in the diagram, the current falls again to zero, the field collapses and the whole of the stored energy is given back to the circuit. Note that during this second quarter cycle the voltage is negative whilst the current is still positive although falling, showing that *power is being given out by the circuit.* As there is no resistance present the whole of this energy is returned to the source of supply.

Now consider the third quarter cycle, from Q to S in Fig. 1. During this time the current is building up again, but in the reverse direction, and energy is once

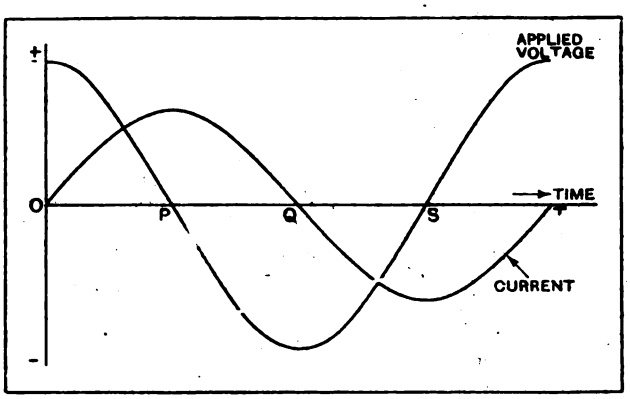

Fig. 1.—For a coil possessing inductance and no resistance the current and voltage waves are 90° out of phase. The average power consumed by such a coil is zero.

more being expended in establishing the magnetic field. The current and voltage are now both negative and their product is therefore positive, proving that power is going into the circuit. Over the last quarter cycle from S to T we have the return of the energy as before.

To sum up, then, it appears that when we drive an alternating current through a circuit possessing inductance only, we put a certain amount of energy into

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Wireless Theory Simplified.—

the field and then withdraw the whole of it once every half cycle, no portion of it being lost as heat. *Thus the average power taken by a pure inductance in an A.C. circuit is zero.* In any circuit where the current and voltage are exactly a quarter of a cycle out of step the conditions are the same, and the average power is zero. It will be seen later that a condenser in an A.C. circuit behaves in the same way.

We have already likened inductance to the inertia or mass possessed by a heavy body, and we can now extend the analogy a little farther to explain the principle of the total return of energy as exhibited by a pure inductance. When a body is set in motion energy is imparted to it and stored as kinetic energy[1] (energy of motion), and when the body is brought to rest again the whole of this energy is withdrawn.

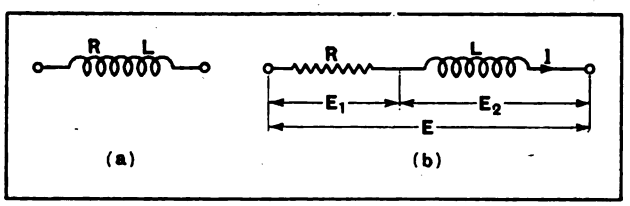

Fig. 2.—A coil possessing both inductance and resistance is equivalent to a pure resistance in series with a pure inductance.

As an example, consider the reciprocating piston of a steam engine. Assume that the steam has been cut off but that the engine is still running, driven by the momentum of the flywheel. At the beginning of a stroke the piston is accelerated, energy being imparted to it from the flywheel through the medium of the crankpin, connecting rod, etc. At about the middle of the stroke the piston reaches its maximum velocity, and beyond this begins to slow down again. Now if there were no friction between the piston and the cylinder walls (equivalent to no resistance in our electric circuit) the piston would tend to move forward, due to its own momentum, without loss of velocity. But it is constrained to slow down again by the crank, and in so doing it exerts a forward pull on the crankpin, so restoring the energy to the flywheel. Thus if the engine were quite frictionless it would go on running indefinitely without steam, the energy given to the piston over the first half of each stroke being recovered during the second half stroke. The same thing is happening in our circuit of pure inductance, where one cycle corresponds to one revolution of the engine crank so that one stroke of the piston represents one half cycle. Energy is given to the circuit and then totally withdrawn again once every half cycle.

Coil with Resistance and Inductance.

So far, we have considered circuits where either resistance or inductance existed alone. In actual practice an inductive coil is wound with wire which necessarily possesses resistance, and in the majority of cases the effects of this resistance are not negligible compared with the effects of the inductance. So now we must consider the behaviour of an inductive coil possessing both resistance R ohms and inductance L henrys, and in so doing we shall make full use of our previous discoveries.

When an alternating current is passed through such a coil its passage is impeded by the combined effects of the resistance and the reactance. It is the same current which simultaneously generates heat in the resistance and produces the magnetic field linked with the turns of the coil. Therefore a coil having resistance R and inductance L, as shown at (*a*) in Fig. 2, will behave in exactly the same way as a circuit consisting of a pure resistance R connected in *series* with a pure inductance of L henrys, as shown at (*b*) in the figure.

Let I amperes be the R.M.S. value of a current driven through the equivalent circuit (*b*) of Fig. 2, the frequency being f cycles per second. We shall set out to find in terms of R and L what voltage E will be required to drive this current through the circuit, and the easiest way to do this is to determine separately the voltages E_1 and E_2 necessary to overcome the resistance R and the reactance X respectively of the circuit, finally adding them together in the proper manner.

Applying Ohm's Law to the pure resistance R, we see that the necessary voltage for this part is $E_1 = IR$, *where E_1 and I are in phase.* The voltage E_2 required to drive the current against the back E.M.F. due to the effects of the inductance will be $E_2 = IX$ volts, where $X = 2\pi fL$ ohms (see Part VI, previous issue), and here the current lags behind E_2 by exactly 90°, i.e., *the voltage E_2 leads the current by* 90°.

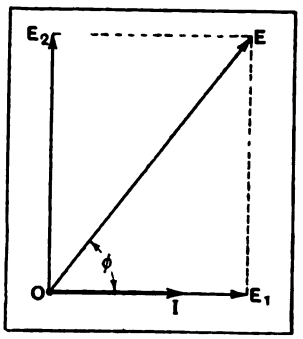

Fig. 3.—Vector diagram of circuit with inductance and resistance in series. OE_1 = voltage used in overcoming the resistance. OE_2 = voltage used in overcoming the reactance. OE = total voltage required to overcome the combined effects of resistance and reactance.

It follows, then, that since E_1 is in phase with the current and E_2 is 90° out of phase, E_1 and E_2 will themselves be a quarter of a cycle out of step and can therefore be represented by two vectors OE_1 and OE_2 mutually at right-angles, the current vector being parallel to OE_1, as shown in Fig. 3. The total voltage E required by the complete circuit or by the coil of Fig. 2 (*a*) is therefore given by the length OE and not by the ordinary arithmetical sum of E_1 and E_2, as explained in Part IV of this series. From Fig. 3 we have

$$OE^2 = OE_1^2 + OE_2^2$$

whence $E = \sqrt{E_1^2 + E_2^2}$ volts

and substituting in this equation the values found above for E_1 and E_2 we get

$$E = \sqrt{I^2R^2 + I^2X^2}$$
$$= I\sqrt{R^2 + X^2}$$

volts, where $X = 2\pi fL$.

[1] If the mass of a body is M and its velocity V the kinetic energy is $\frac{1}{2}MV^2$. Compare this with $\frac{1}{2}LI^2$ for magnetic energy.

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Wireless Theory Simplified.—

Modification of Ohm's Law.

The quantity $\sqrt{R^2+X^2}$ is the number by which the current must be multiplied to give the voltage, or by which the voltage must be divided to give the current. It is called the *impedance* of the coil or circuit and is usually denoted by Z. Since Z is the ratio of voltage to current it is expressed in ohms, and thus for an inductive circuit we have the relationship

$$I=\frac{E}{Z} \text{ amperes,}$$

where $Z=\sqrt{R^2+(2\pi fL)^2}$ ohms.

In an A.C. circuit, then, Z takes the place of R in Ohm's Law for a D.C. circuit. The impedance Z is the *total* opposition encountered by the current, being due to the combined effects of resistance and reactance. To obtain the impedance we must add the resistance and the reactance together as though they were two lines of lengths R and X respectively *at right-angles to each other*. If two lines *ab* and *bc* are drawn mutually at right-angles, the length of one being equal to R and the other being equal to X to some convenient scale as in Fig. 4, then *ac* will give the impedance to the same scale. Such a triangle is called the *impedance triangle* of the circuit.

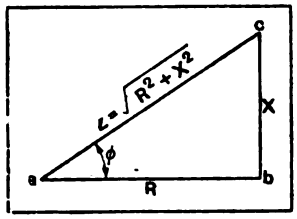

Fig. 4.—Impedance triangle of inductive circuit. R is the resistance, X the reactance, and Z the impedance of the circuit. ϕ is the angle of lag.

Angle of Lag in an Inductive Circuit.

We have found the relationship between the voltage and current as far as their magnitudes are concerned, but very often it is necessary to know how far out of step or out of phase they are. This can be found quite easily from the diagram of Fig. 3. It will be noticed that the current lags behind the applied voltage E by an angle which is less than 90°. This was to be expected because for a pure resistance there is no angle of lag and for a pure inductance the angle of lag is 90°, and therefore for a combination of both resistance and reactance the angle of lag must be less than 90° and greater than zero. Let ϕ denote the angle between E and I. Then $\cos\phi=\frac{OE_1}{OE}=\frac{IR}{IZ}=\frac{R}{Z}$. (In a right-angled triangle the *cosine* of one of the smaller angles is the ratio of the side adjacent to that angle to the length of the side opposite the right-angle.) Thus in the impedance triangle of Fig. 4 the angle of lag ϕ is the one lying between R and Z as shown.

Numerical Example.

Before discussing the power absorbed by this circuit a numerical calculation of the relationship between current and voltage will be helpful. Suppose, for example, that we have a low-frequency choke of 20 henrys inductance and 1,000 ohms resistance under working conditions connected in the plate circuit of a valve whose internal resistance (so-called impedance) is 3,000 ohms. It is desired to find the A.C. component of the current through the choke and the voltage across it when 10 volts (R.M.S. value) at 100 cycles per second is applied to the grid of the valve, the amplification factor being 5. This means that a voltage of $5\times10=50$ will be generated in the anode circuit. Neglecting battery resistance, the total resistance of the anode circuit will be $1,000+3,000=4,000$ ohms, and the reactance $2\pi fL=2\pi\times100\times20=4,000\pi$ ohms at 100 cycles.

The impedance of the complete circuit will thus be

$$Z=\sqrt{4,000^2+(4,000\pi)^2}$$
$$=4,000\sqrt{1+\pi^2}=13,200 \text{ ohms.}$$

The current $=\frac{E}{Z}=\frac{50}{13,200}=0.00379$ amp. or 3.79 milliamps.

The impedance of the choke alone is

$$Z_c=\sqrt{1,000^2+(4,000\pi)^2}=12,600 \text{ ohms,}$$

and so the 100 cycle voltage across the coil will be

$$E=IZ_c=0.00379\times12,600$$
$$=47.8 \text{ volts.}$$

(To be continued.)

Dutch Amateurs.

Through the courtesy of G 6PP we are able to give below a list of the licensed amateur stations in Holland which he had received from the QRA Manager of the N.V.I.R. :—

PAOAA Reserved for the N.V.I.R.
PAOAB Reserved for the N.V.I.R.
PAOAC Reserved for the N.V.I.R.
PAOAF Dr. K. Beintema, Petrus Hendrikszstraat 19A, Groningen.
PAOBG A. J. van Gilse, Obrechtstraat 212, The Hague.
PAOBP P. L. H. Beck, Gasthuisstraat 14, Venlo.
PAOBZ F. Brouwer, Beeklaan 216, The Hague.
PAOCA Ir. W. H. Moorrees, Crispijnsche weg 175, Dordrecht.
PAOCO C. C. Verbeck, Noordwijk Radio, Noordwijkerhout.
PAODA A. N. Dekker, v. Ewijkslnis.
PAODM J. A. Hogesteeger, van Oosterzeestraat 81b, Rotterdam.
PAODW B. J. C. Pothast, Eemnesserweg 23, Laren (N.H.).
PAOFB J. Adama, Noordestationstraat 47, Groningen.

TRANSMITTERS' NOTES.

PAOFR F. Baron Sloet tot Everlo, Emmastraat 49, Hilversum.
PAOGA Th. C. van Braak, Halscheweg 462, Varsseveld.
PAOJR J. G. J. Ros, Spoorstraat 28, Hilversum.
PAOLY W. B. M. Blommaart, Wilhelminastraat 326, St. Jans-een (Z).
PAOMAR L. Lindeman, Maratakstraat 25, The Hague.
PAOML M. Leeuwin, Philips Radio Factories, Eindhoven.
PAONF N. Fonderie, Geestbrugweg 83, Rijswijk (Z.H.).
PAONWK J. van der Wijk, Fahrenheitstraat 370, The Hague.
PAOPG F. Dubel, Bronckhorststraat 11, Amsterdam (Z).
PAOQQ C. A. Gehrels, Nic. Beetstraat 92, Eindhoven
PAORA Ir. H. Lels, Dordrecht.
PAORZ C. Jobse, Stokroosstraat 5b, Rotterdam.
PAOSV A. O. L. Strijkers, Operator, Air Harbour Waalhaven, Rotterdam.
PAOTW Th. J. Wilmink, Groningen.
PAOVP L.L. van Praag, Tamarindestraat 84, The Hague.
PAOWIM W. H. Nowee, Eschdoornstraat 77, The Hague.
PAOWJ J. F. W. Jordans, Galileistraat 171, The Hague.
PAOWX A. E. Karsen, Mathenesserweg 121, Rotterdam.
PAOXH J. Hagenaar, Eindenhoutstraat 11, Haarlem.
PAOYY H. Pomes, Simonstraat 94, Delft.
PAOZK W. Keeman, Caen van Necklaan 227, Rijswijk (Z.H.).

QRA's Wanted.

VQ 1DZ.

New Call-Signs and Stations Identified.

G 6HR W. D. Keiller, 21, Newton Way, Cambridge Road, Edmonton, N. 18. (Change of address).
2BJG (ex BRS 204). A. E. Groom, 13, William Street, Luton, Beds (willing to stand by for any station on 10, 20, 40 or 160 metres by arrangement, and report on signals received).

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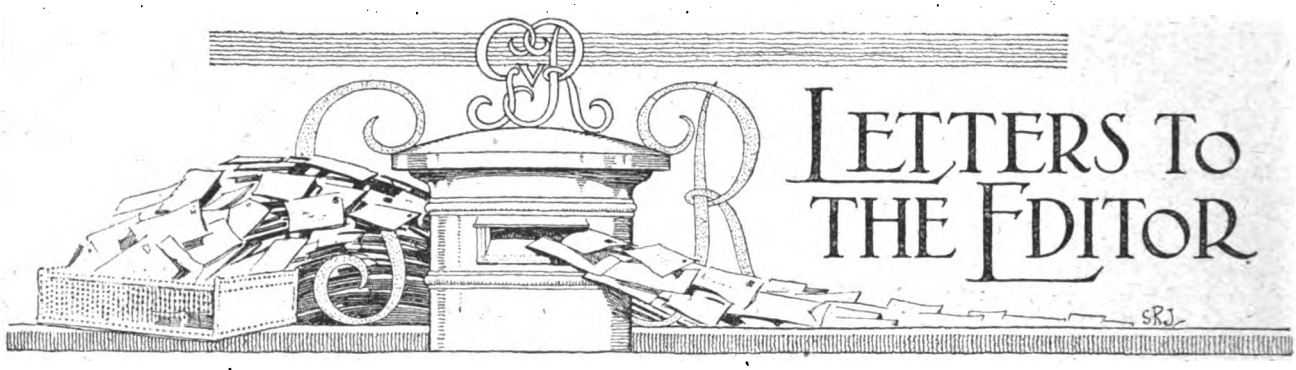

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

NON-RADIATING SETS.

Sir,—This letter is inspired by the fact that my attempts to receive the broadcast lecture given recently by Mr. H. G. Wells were frustrated by the heterodyne howls of neighbours who could not leave their receivers alone.

Some years ago a serious attempt was made to prevent oscillation by the prohibition of reaction. As everyone knows, that attempt had to be abandoned owing to the fact that reaction, either by the swinging coil or by capacity control, or disguised as H.F. transformers with an amplification of unity, was essential to obtain either sensitivity or selectivity. In other words, none but a receiver capable of passing back energy to the aerial was worth possessing. The introduction of neutralised H.F. amplifiers did little to alter the position owing to the fact that their users for the great part upset the neutralising condenser settings sufficiently to pick up carrier waves by heterodyning.

It seems to the writer that the advent of the screen grid valve has sufficiently altered the position to justify legislation to prohibit the use of receivers capable of energising the aerial and, it is suggested, that it would prove of considerable interest to obtain the views of your readers on this point.

Huddersfield. HENRY W. MOSS.

EMPIRE BROADCASTING.

Sir,—As you point out in your leader of October 23rd, what a splendid opportunity exists at the moment for a definite policy with *immediate action* in regard to Empire Broadcasting.

In the light of present technical knowlege there is no earthly, ethereal, or financial reason why arrangements for a twenty-four-hour Empire service should not be put in hand forthwith.

Your own endeavours, coupled with those of Mr. Gerald Marcuse, were very much appreciated by all your Overseas readers, as I found out on my tour to the Dominions in connection with Empire broadcasting.

Now that the project of Empire Free Trade is so very much to the fore, I would like to suggest that a committee be formed, sponsored by yourselves, whereby we should be in a position to answer any pertinent questions regarding a greatly extended broadcasting service within the Empire that may be put forward by responsible authorities.

It is not necessary to enlarge upon the assistance that would be given to the cause of Empire Free Trade by a really efficient Empire broadcasting service. H. ANTHONY HANKEY.

London, W.6.

B.B.C. TRANSMISSIONS.

Sir,—The letter regarding the B.B.C. transmissions published in the October 23rd issue of *The Wireless World* was read by request at an open meeting of the Edinburgh and District Radio Society on Wednesday evening.

The observations of Mr. McCormack received so cordial an endorsement from every member present that I was asked to convey their appreciation to him through the medium of your valued periodical.

He summarised very tersely the points submitted by our council to the B.B.C. secretary last winter. I crave your permission to add the following comments.

The members of our society, about 100 in all, rank the "wireless link" transmissions as worse than tenth-rate—so bad in fact that they defy classification.

In the sweet by and by we are promised a Scottish regional station. And so there are probably at least two more years of land-line relays, two more years of continued depression for our excellent receiving sets.

In conclusion I submit the following questions:

1. Cannot the B.B.C. or the Post Office, or both, set about *immediately* improving, by extension or otherwise, their land-line service?

2. Will these land-line relays go on as merrily, even after the regional station is erected and in operation?

3. Or will the B.B.C. install, along with the mechanical and electrical apparatus of the new station, a resident body of artistes, musical and otherwise, equal to the best that London can provide? W. ANDERSON

(Chairman of Edinburgh and District Radio Society).

Edinburgh.

Sir,—I have read with very great interest the letter in the current issue of *The Wireless World* by Mr. K. McCormack, of Newcastle-on-Tyne, on the subject of B.B.C. transmissions. He stresses the very important fact, which is not, I think, generally recognised, that to obtain a perfect transmission the microphone must be near the transmitter.

I quite agree with his point that Daventry is a second-rate transmission, and remember five years ago the night on which 5XX transmitted from Daventry for the first time, being delighted with the increased signal strength but disappointed with the quality, which I did not think so good as previously received from Chelmsford, due, as I thought at the time, to the longer land-line. Long relays, though clear and distinct, are indeed of very poor quality, and it does not need the transmission of music to prove this, as it is apparent in the transmission of the speaking voice, and I could not help thinking as I listened to Mr. Shaw's broadcast 10 days ago from Plymouth, how much more real his voice would have sounded had he been broadcasting from 2LO.

Unfortunately, there seems to be no remedy for this state of affairs, which is due to the fact that 75 per cent. of transmissions emanate from London, which city could hardly be in a worse position from a wireless point of view, being at one end of a long narrow island. E. P. HARDING.

Beverley.

SPARE APPARATUS.

It is regretted that by an oversight we omitted to include the address with the letter which was published appealing for spare wireless gear for the Society of Big Brothers in the East End. The address of the headquarters is St. Jude's Hall, St. Jude's Church, Old Bethnal Green Road, E.2.

Many readers have written asking for the address and offering to forward apparatus, and we have arranged to put them in touch with the Society.

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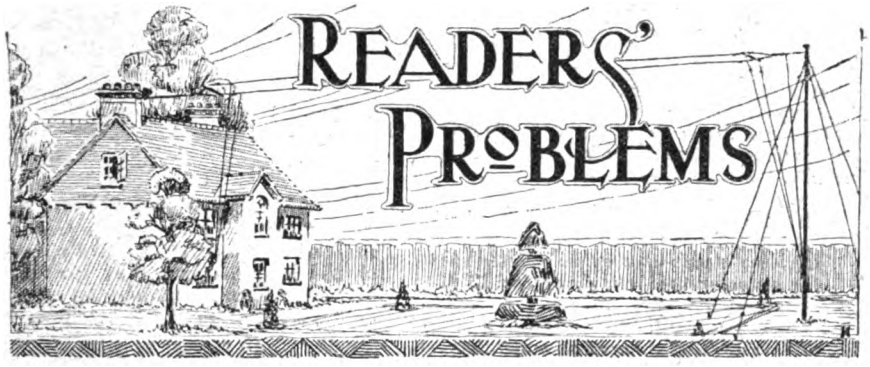

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

An Expensive Failure.

Can you tell me why the output valve of my . . . . . receiver does not last more than a few weeks? Valve after valve has been returned to my dealer, who tells me that the manufacturers advise him that emission has failed, due to overrunning. An H.T. accumulator with a voltage slightly below the maximum recommended pressure of the valve is used, so there can be no question of my having exceeded the manufacturers' limit. To assist you in making a diagnosis it should perhaps be said that the set worked very well for about six months after it was purchased, but quality has been distinctly poor since the output valve trouble manifested itself. The fault does not lie in the batteries, as all voltages (H.T., L.T., and grid bias) have been checked with a voltmeter. L. P. W.

The set you are using includes resistance coupling in each of its L.F. stages, and we are fairly confident that the trouble will be traced to a disconnection in the grid circuit of the output valve; this would prevent the necessary negative bias from reaching its grid, and consequently anode current would be excessive, and the valve would quickly lose its emission.

It should be an easy matter to test through the circuit with a pair of phones and a dry battery, and we think that in all probability it will be found that the grid leak itself is at fault; it should be replaced by a new one.

° ° ° °

Portable Sets with Aerials.

At different times I have tried several commercial portables connected to an outside aerial in the manner provided by the manufacturers, and notice in every case that, used in this way, the sets are far from selective. Is there any way of overcoming this disadvantage? J. W. D.

Most portable receivers include either one or more stages of "aperiodic" H.F. amplification, which does not in itself contribute anything to their overall selectivity; it must not be forgotten that they are primarily designed for use with a frame, and it is hardly fair to expect them not to suffer from interference troubles when an outside aerial is added.

° ° ° °

Modernising the "Everyman Four."

Would it be possible to use the coils as specified for the "1930 Everyman Four" in the original set? I refer particularly to the long-wave windings; it would be an advantage to have H.F. magnification on this band. L. F. P.

The long-wave transformer described is unsuitable for use with a neutralised triode H.F. amplifier, and even if it were modified by adding a neutralising winding, we do not think that satisfactory results would be attained unless fairly sweeping modifications were introduced; it is not particularly easy to devise a set with a really efficient neutralised H.F. stage combined with waveband switching.

Raw A.C. for Filament Heating.

I believe that it is quite common practice nowadays to use ordinary battery valves with their filaments connected directly across the low-voltage winding of a suitable transformer in the output position of an "all A.C." receiver. Has this plan proved itself as being entirely satisfactory in practice? If so, I am thinking of incorporating it in my new set. R. P. S.

It may be stated definitely that a large number—perhaps the majority—of commercial A.C. sets include this arrangement, which, incidentally, has also been used in *Wireless World* sets. You need have no hesitation in adopting it.

° ° ° °

An Inexpensive Eliminator.

Will you please criticise my circuit diagram of an A.C. eliminator for the S.G. Regional receiver? I am going to use a Westinghouse H.T.3 metal rectifier, and, as you will see, have followed the general idea of the makers' recommended circuit, but have made provision for only one main output and a critically controlled voltage for the screening grid of the H.F. valve.

With a suitable mains transformer, an eliminator on these lines is stated to have a voltage output of 120 at 20 milliamps. I assume that this will be sufficient for the S.G. Regional receiver? S. C.

As the set in question is inherently free from interaction troubles, there is no reason why your proposed circuit arrangement (which is reproduced in Fig. 1) should not be entirely satisfactory, and the output from it should be quite sufficient for average requirements.

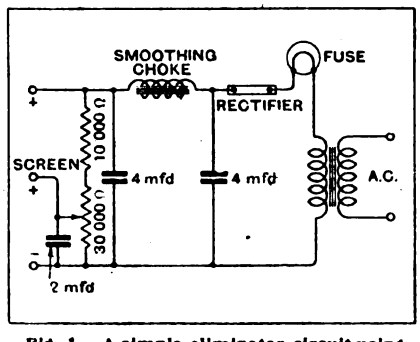

Fig. 1.—A simple eliminator circuit using a Westinghouse metal rectifier.

We would point out that, although your diagram is correct in essentials, the relative values of the resistances of the potentiometer for controlling screening grid supply are incorrect; you show both the fixed and variable elements as having a resistance of 30,000 ohms. With this combination it is impossible to obtain a supply voltage of more than 60 volts; this will be reduced if the circuit happens to consume an appreciable current. We suggest that the fixed resistance should be reduced to 10,000 ohms, and have shown this alteration on the diagram.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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H.F. By-pass Condensers.

It is noticed that by-pass condensers of 0.1 mfd. are generally used in association with decoupling resistance in the H.F. circuits of receivers described in your journal. I take it that a somewhat lower capacity would be effective in a set designed only for the medium broadcast band; I have a number of 0.01 mica condensers; would these be suitable? A. F. E.

Yes. It is necessary that by-pass condensers in these circuits should have a negligibly low reactance over the band of frequencies covered by the receiver; in the case of a set with a maximum wavelength of, say, 600 metres this condition would be amply fulfilled by a condenser having a capacity of 0.01 mfd. The fact that your components have a mica dielectric is all to the good.

A "1930 Everyman" Addition.

Will you please give me a diagram showing how a pick-up may be inserted in the detector grid circuit of the 1930 Everyman Four? I take it that this is the best position for the insertion of this additional piece of apparatus. E. P. M.

When the pick-up is placed in the detector grid circuit, it will be followed by three amplifying stages, and consequently the question of whether this is the best position for it depends on the sensitivity (or average voltage output) of the pick-up itself. In any case, this arrangement should work quite well, as the present post-detection volume control will be operative.

A suitable method of connection is shown in Fig. 2 (*a*); this offers the advantage that bias is automatically changed to suit amplifying or detecting conditions by operation of the switch.

It is possible to devise an even simpler form of connection by inserting the pick-up in the existing grid return lead (the lead between the low-potential end of the tuned circuit and the bias battery) and connecting a short-circuiting switch across it. Bias would, of course, be adjusted by operation of the potentiometer, and the H.F. valve would be turned off by means of its rheostat.

We would refer you to our reply to "T. C. A." in this issue.

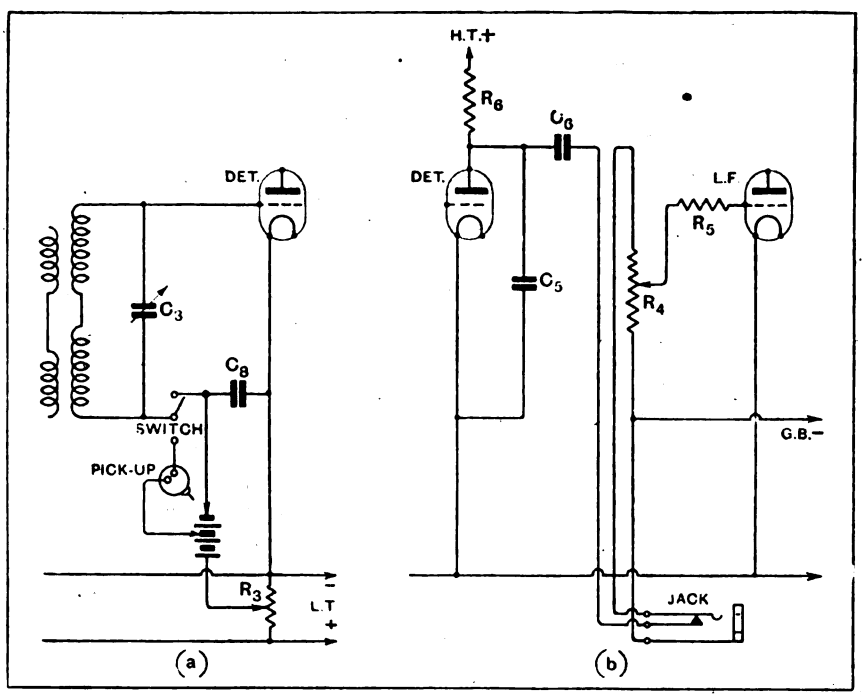

Fig. 2.—Alternative methods of connecting a pick-up to the 1930 Everyman Four. It may be inserted in (a) the detector grid circuit, or (b) the first L.F. amplifier grid circuit.

In Anticipation of Trouble.

I am about to build a new receiver, and am attracted by the design of "The Wireless World Kit Set." My problem is this: I live about twenty miles from the proposed Moorside Edge regional station, and am not sure whether the receiver will be sufficiently selective when the new twin transmitter starts operations. Will you give me your advice on this matter? T. B. A.

You can rest assured that the "Kit Set" will be sufficiently selective for use in your locality, even if radiation from the new twin station is greater than that from Brookmans Park. Even if the set were operated with optimum aerial coupling (from the point of view of signal strength), there should be very little "spreading" at a distance of twenty miles with a receiver of this type, and any tendency in this direction could be still further restricted by slightly loosening the coupling between open and closed circuits.

Alternative Pick-up Connection.

Will you please show me how a pick-up may be connected in the grid circuit of the first L.F. valve of the 1930 Everyman Four, preferably by means of a plug and jack? If possible, I should like to use the present volume control resistance R_4 for regulating intensity when the pick-up is in use. T. C. A.

Provided your pick-up is moderately sensitive (see our reply to "E. P. M.") there should be no difficulty in connecting the pick-up in the manner you desire, and it will be possible to use the present grid input potentiometer as a volume control for both radio and gramophone reproduction.

Suitable connections are shown in Fig. 2 (*b*).

In the interests of economy it will be necessary to make some provision for breaking the filament circuits of H.F. and detector valves; this can be done by means of a pair of extra contacts on the jack, or by an extra single-pole switch, as you prefer.

FOREIGN BROADCAST GUIDE.

HUIZEN
(Holland).

Geographical position: 52° 18′ 00″ N. 5° 12′ 00″ E.

Approximate air line from London: 235 miles.

Wavelength: 1,875 m. Frequency: 160 kc. Power: 6.5 kw.

Time: Amsterdam (20 minutes in advance of G.M.T).

Standard Daily Transmissions.

G.M.T. 10.10 sacred service; 11.40 concert; 13.40 schools; 16.40, 18.10 and 20.00 musical entertainments.

Male announcer. Call: *Hier Huizen*, with initials of society presenting radio programme. Announcements are made in the Dutch language only.

Time signals (Westminster chimes) are given almost hourly throughout the day.

Programmes are transmitted by N.C.R.V. (Netherlands Christian Broadcasting Company); K.R.O. (Catholic Broadcasting Company); V.P.R.O. (Protestant Freethinkers' Radio Association), these initials being associated with the call (q.v.).

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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MECHANICAL MUSIC AND THE MUSICIAN.

THE very vexed question of whether broadcasting constitutes a menace to the professional musician has been a subject of discussion ever since broadcasting was introduced, and the fight between societies of musicians and broadcasting is still an undecided battle in this country. In America, where broadcasting had a considerable start over our own country, it had seemed that some sort of understanding between the musician and the broadcaster had been reached; but the arrival of the "talkies" and the great advances which have been made towards perfecting the gramophone record appear to have been watched with the greatest anxiety by professional musicians in the United States. Recently we have seen large advertising spaces in American newspapers taken by the American Federation of Musicians, with the object of trying to arrest the encroachment of mechanical music where it is feared the new art will oust the professional musician.

Some of the arguments put forward by the American Federation of Musicians do not seem to us to ring true, as, for instance, a statement that "The cultural menace of this movement to supplant Real Music with the flat, savourless monotony of Mechanical Music becomes apparent upon a moment's thought." Is it not the generally accepted view that broadcasting resulted in a vast extension of the musical public and an enlarging of the appetite of the world for music of all kinds?

The extension of the use of what is described as mechanical music must, we fear, result in less employment amongst individual *performing* musicians, but may not this prove to be only a temporary objection and not one which is likely to have any lasting effect to the detriment of music generally, nor to the disadvantage of the community, for surely the increased taste for music must stimulate the demand for *creative* musicians in every grade of the art.

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"THE WIRELESS WORLD" OLYMPIA SHOW COMPETITION.

WE are now able to announce the names of the winners of the prizes which were offered by *The Wireless World* in connection with our Olympia Show Competition. The prizes, it will be remembered, were to be awarded to the competitors who succeeded in correctly forecasting the outstanding single exhibit at Olympia, as decided by the majority of votes, and who also had the largest number of correct forecasts in the other classes of apparatus.

The first prize of £50 goes to Mr. A. Vernon, 214, Bradford Road, Manchester. The second prize, of a voucher for the purchase of apparatus to the value of £20 from firms who exhibited at the Olympia Show, is gained by Mr. Albert Maunders, 95, Bradshaw Street, Nelson, Lancs; whilst third, fourth and fifth prizes, of similar vouchers to the value of £15, £10, and £5 respectively, go to Mr. H. J. Whitehouse, 12, June Avenue, Bromborough, Cheshire; Mr. William M. Moore, 30, Mariners' Cottages, South Shields; and Mr. Walter R. Johnstone, 5, Linden Road, Levenshulme, Manchester. The winners have already been notified of their successes by letter.

Elsewhere in this issue, as we had previously announced, we illustrate and describe the apparatus which has gained the largest number of votes in each of the classes into which we divided the exhibits at Olympia as a whole, and we have made this an occasion for introducing photogravure reproduction to illustrate the apparatus, as we felt that the winning products merited some special distinction such as this method of illustration provides.

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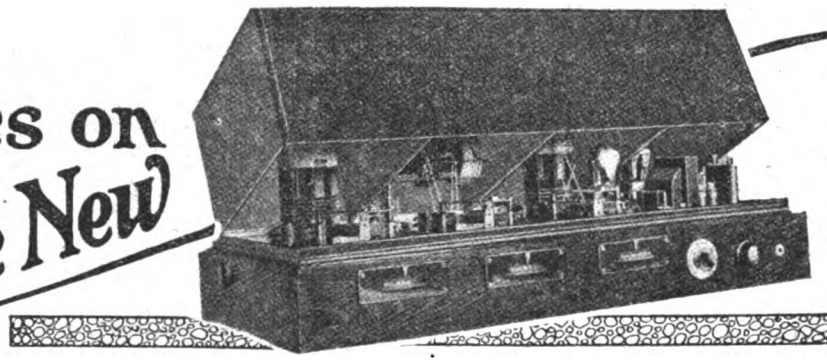
Notes on The New Kilo-Mag Four



Modifications to Suit Individual Requirements.

By H. F. SMITH.

BEFORE attempting to supplement the information already given on the subject of the new Kilo-Mag Four receiver,[1] it would seem advisable to deal with the highly topical question of selectivity—undoubtedly the burning problem of the hour to a great number of wireless users, and a matter of interest to the majority of listeners who look ahead, even though they may, at the moment, be unaffected by the changing technique of broadcast distribution.

The set as described seems to have proved itself to be sufficiently selective for use under average conditions, and experience has shown that it is hardly practicable to improve its performance in this respect without sacrificing H.F. amplification, increasing operating difficulties, or decreasing circuit resistance to a point where high-note loss becomes apparent.

When dealing with a receiver that is frankly designed for long-distance reception one naturally hesitates before suggesting any palliatives for interference troubles that will bring about any considerable reduction in sensitivity, but it must not be forgotten that the amplification provided is sometimes greater than can be conveniently handled, and it is with a clear conscience that one can recommend such practices as reducing the number of primary turns on the H.F. transformers. It is quite permissible to reduce the medium- and long-wave primaries to, respectively, 20 and 70 turns. It should be made clear that such a drastic reduction as this is seldom necessary, and that it is best to take off a few turns at a time. These should be removed from the ends of the winding nearest to the anode connection.

Mention was made in the descriptive article of the fact that interference can be lessened by moving medium- and long-wave aerial connections nearer to the earthed ends of the appropriate input coils. As a refinement, alternative connections may be provided.

Another way of increasing selectivity—but still at the expense of amplification and high-note retention—is offered by increasing the ratio of capacity to inductance in the tuned circuits. To make this alteration variable condensers of 0.0005 mfd. should be used, and a few turns should be removed from the aerial-grid coils and from the H.F. transformer secondaries.

[1] *The Wireless World*, August 14th and August 21st, 1929.

It is hardly suggested that the above rather drastic expedient should be applied to existing sets; instead of going to the expense of obtaining a new set of condensers it is certainly better to fit a loosely coupled and separately tuned aerial circuit, which is a real remedy as opposed to a mere palliative. This addition was mentioned tentatively in the earlier article; it can now be advocated without apologies, as there are definite signs that a general return to the two-circuit aerial tuner, consistently advocated by writers in this journal, is at last in sight.

Increasing Both Range and Selectivity.

There are several ways of making this addition to the receiver as it stands, and useful hints on the subject may be gleaned by studying the articles describing *The Wireless World* "Kit Set" (September 18th) and the 1930 Everyman Four (October 16th). Perhaps as suitable and convenient a method as any is that given in Fig. 1, which shows an arrangement with continuously variable capacity coupling. This requires the addition

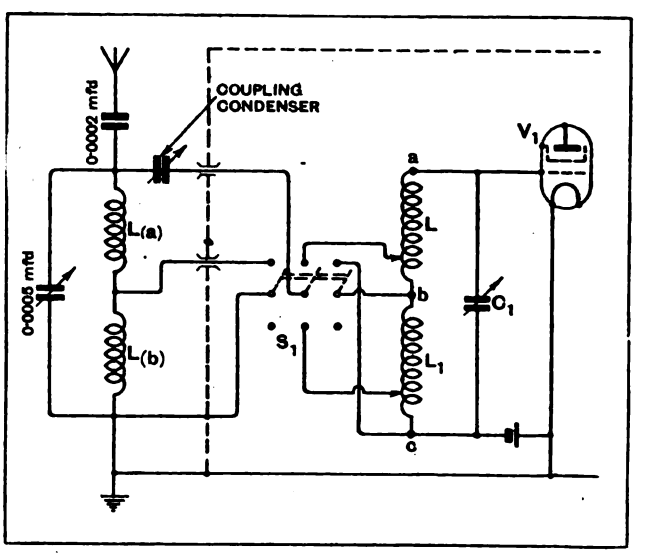


Fig. 1.—How to add a separately tuned aerial circuit: the medium- and long-wave aerial coils (L(a) and L(b)), and the extra condensers may be mounted outside the screening compartments.

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Notes on the New Kilo-Mag Four.—

of an extra pole to the existing wave-range switch S_1, but this component need not be replaced if interchangeable coils, mounted externally at the back or side of the cabinet base, are used in the aerial circuit. These extra inductances are marked L(*a*) and L(*b*) in Fig. 1, and may conveniently be constructed in the same way as those specified for the "Kit Set." The general arrangement of components adopted in this latter receiver may be imitated as far as possible, bearing in mind that the aerial tuning condenser, of 0.0005 mfd., must be of exceptionally small overall dimensions. The same applies to the coupling condenser, which may have a maximum capacity of 0.0001 mfd., with a small minimum value.

The spindles of these condensers may be mounted through either the front or left-hand side panel of the base compartment; in the latter position small edgewise dials should be used. Incidentally, it is here assumed that the set is (or will be) housed in a special *Wireless World* metal cabinet; although this course is to be recommended on the score of easy construction, it should be made quite clear that more conventional methods may be adopted, always provided that screening is adequate.

It is reassuring to have to report that the majority of constructors seem to have had no difficulty in getting the set into a state of satisfactory operation, and that puzzling faults have been few and far between. Where trouble is encountered, it is usually traced quite easily by systematic testing.

A Rapid Method of Fault-finding.

These tests may be made quickly by the stage-by-stage method. To assure oneself that the detector, its preceding H.F. transformer, and its succeeding L.F. amplifier are in order, the plate lead of the second H.F. valve should be removed, and the aerial joined to this lead through a 0.0001 mfd. fixed condenser. The receiver should now work as a simple detector-L.F. set, and, as such, would be expected to provide good signals from a local station. Both H.F. valves are either switched off or removed.

Carrying the test a step farther, the aerial wire (still *via* a fixed condenser) is transferred to the plate lead of the first H.F. valve, after disconnecting this lead from the valve cap. This gives us a medium-range H.F.-det.-L.F. combination, and good results will show that the second H.F. valve and its associated apparatus are in order. Obviously, then, failure to obtain the performance to be expected when the aerial is restored to its original position will indicate that the fault lies in the first H.F. valve or in the apparatus connected in one of its circuits, although, if instability is encountered under these conditions, the blame may possibly be allocated between the two H.F. stages—most probably to defective screening.

There seems to be some uncertainty as to whether the set can be used with the Mazda 215 S.G. valves, which came on the market shortly after it was first described. Although the characteristics of these valves are not quite in line with more conventional types, they can be used with complete satisfaction without any modification of the transformers, and they will afford a very high amplification. If 6-volt valves are used in the remaining positions, it is convenient to reduce the value of the rheostat R_9 to some 15 or 20 ohms, and, as a safety measure, to insert in series with it a semi-fixed resistance set at 13 ohms.

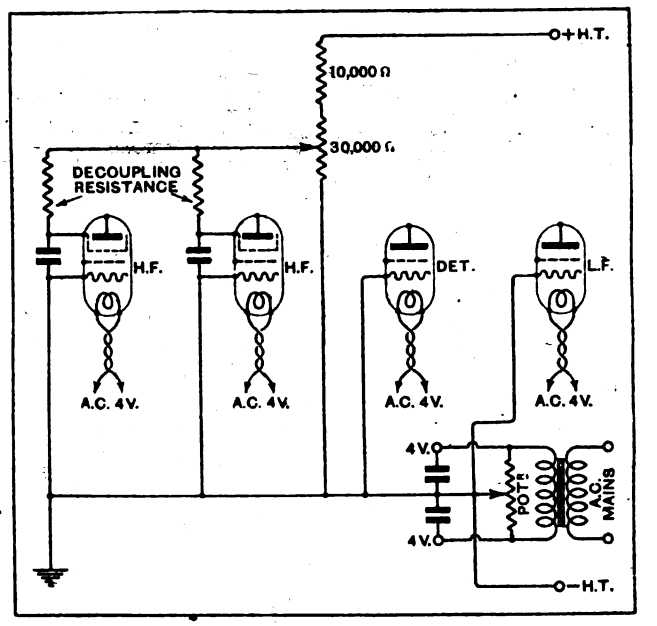

Fig. 2.—The Kilo-Mag Four receiver may be operated with A.C. valves without any alterations to its basic circuit. This diagram shows a suitable method of connecting heater and cathode circuits, and also a potentiometer arrangement for controlling screening grid voltage. Condensers across the low-tension potentiometer may be of 0.005 mfd.

The connection of a gramophone pick-up has already been described in the "Readers' Problems" section of *The Wireless World* of September 4th. There are several possible ways of making this addition; all that one has to do is to arrange to insert the pick-up in series with the detector grid circuit, and at the same time to make the appropriate reduction in negative bias. As a refinement, means can be provided for automatically switching off the H.F. valve filaments, but this operation can be carried out by means of the rheostat already fitted.

Two minor errors were allowed to pass into the original description; the writer takes this opportunity of apologising and again drawing the reader's attention to them. In the "List of Parts" the value of the variable volume-control resistance R_7 was given as 20,000 ohms. This should be 200,000 ohms. Referring to the practical wiring plan, there was a fairly obvious transposition of the reference lettering on each of the H.F. valve-holder filament terminals. The terminals "earthed" to the metal screening base should be connected to L.T. negative, and consequently should be lettered *r* and *t*; they are joined to the soldering tag on the jack frame by separate leads bearing corresponding identification marks. The remaining filament terminals should be marked *s* and *u* (instead of *r* and *t*), and are connected by flexible leads to the same terminal on the rheostat R_9.

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My Household Set

A Switch-operated Receiver With Remote Control.

By CAPTAIN IAN FRASER, C.B.E.

A FEW months ago I built myself a new house. The opportunity was thus afforded and the excuse provided for the design and installation of a new wireless receiver. What did I really want?

I started listening before the War to the Eiffel Tower news and to ships. A set at Marlborough College, largely contrived from gas tubing, crystals and odd pieces borrowed from the "stinks" laboratory, formed the basis of my experiments. I listened to amateurs before broadcasting began, and have possessed or borrowed or made almost every possible kind of set. In my experience distant stations are amusing to "get" but seldom worth listening to, owing to incidental noises. I have come to the conclusion that the keen amateur should have a set for his own use, perhaps two or more if he can afford them, but that for his own sake and that of his family his household set should be separate and different. It is the household set I propose to discuss here.

For a residence in or near London such a set should, I think, receive 2LO and Daventry 5GB at full strength without the bother of tuning, and should come into operation by means of the pressing of a switch. If possible one switch button should operate "on," "off," and also the change from one station to the other.

The first problem was to devise this switching mechanism. Doubtless there are other methods of doing this job than that which I have chosen, but as it took me some time and two or three unsuccessful experiments and numerous enquiries before it was finished, it might be worth while describing it in detail.

The set is in a safe place in an out-of-the-way cupboard. This pleases the æsthetic eye, and prevents interested friends from tuning it in. The receiver feeds four loud speakers, and close to where these are located is a neat switchboard upon which are two controls. One is a press button to put the set on or off, and to change stations, and the other is a variable control for the volume of the particular loud speaker with which it is associated. A three wire lead-covered cable connects the loud speakers to the set. We shall call the three wires black, red and white, because it will facilitate explanation. Black and red are connected to the output side of an output transformer from the receiver. Their other ends are connected to the terminals of the loud speakers or to a second transformer, according to the type of loud speaker employed. White and red are the wires which operate the switching mechanism. The primary relay circuit consists of a nine-volt dry battery, the relay coil, the wires, red and white, and the press button. The armature operates an eight-toothed sprocket wheel, moving it one tooth every time the circuit is closed. On the sprocket wheel spindle is an ebonite rod or small diameter drum upon which are the necessary contacts for two switches.

The first switch is responsible for putting on the current to operate the set. Positions 2, 4, 6 and 8 of the ebonite rod make contact, and positions 1, 3, 5 and 7 make no contact. Hence, so far as this switch is concerned, successive presses upon the press button will put the receiver on and off from any remote control point indefinitely or, to be strictly accurate, until the dry battery runs down. It is to be noted in passing that the current is not flowing all the time in this switch circuit but only at the moment of operation, with a corresponding economy in the use of the dry battery.

The author photographed in his laboratory. Captain Fraser has been a leading amateur for many years and is a Past President of the Radio Society of Great Britain.

The other switch, mounted upon the same ebonite spindle, is used to operate the wavelength changing device. This is so arranged that with one press-button switch we get these results following successive pressings of the button: "on" London—"off" - "on" 5GB—"off"-"on" London—"off" - "on" 5GB—"off," etc., *ad infinitum*.

The switch I have described could probably be constructed to operate the set and the wave change directly, but there is not, I think, such a switch on the market, and I had to use a second stage of relaying or have a switch made. I chose the former course. I secured a remote control switch from Messrs. Gamages, which was a slight variation of their standard arrangement. It had larger silver contact points than is usual and two switches upon the spindle instead of one. I then ordered two relay switches from Messrs. Isenthal, consisting of

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My Household Set.—

an armature carrying a mercury bottle, and operated by a magnet coil wound for 240 volts D.C. The switch that puts the set "on" and "off" is a single-pole mercury switch; the other, which changes the wavelength, is a two-pole mercury switch. The "on"-"off" switch is simply connected to the main supply to the set for H.T. and L.T.

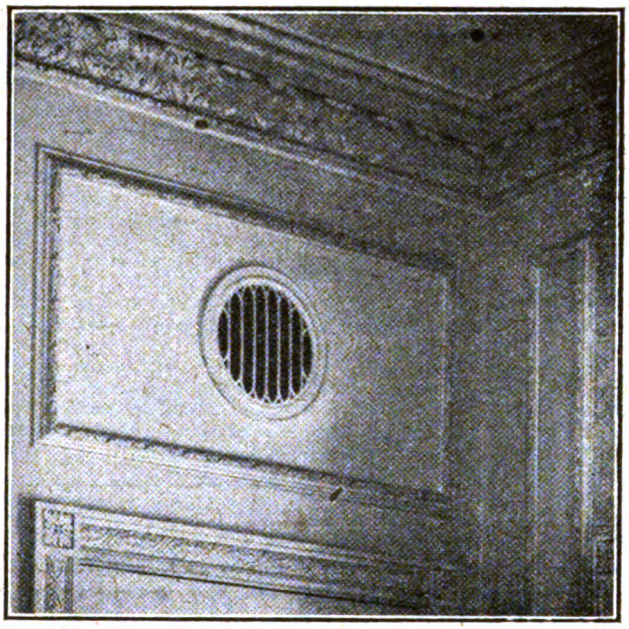
The double-pole switch connects two independent 0.0003 variable condensers to the two existing tuning condensers of the set. The earthed sides of these condensers are permanently connected, and the high potential sides are the two which are switched. When the two independent condensers are brought in in parallel with the existing condensers the requisite increase of capacity and consequently of wavelength is made to raise the tuning from that required for 2LO to that appropriate for 5GB.

The more sensitive the receiver the more care would have to be taken not to let these added condensers and their connecting wires, etc., introduce unwanted capacities. I find no difficulty on this account, and the apparatus is instant and reliable in its operation.

The Isenthal relays are held on all the time they are operating and are using current therefore, but this is of the order of a few milliamps from the main and can be ignored. When twin transmissions from Brookmans Park begin we shall have two signals of equal strength coming from the same point, and it will be much easier to deal with this than with the alternatives of 2LO and Daventry Junior. Doubtless a single detector valve, without H.F. amplifiers, will suffice, and the double-mercury Isenthal switch described above, which is constructed for use as a double-pole double-throw switch, can be used for disconnecting one condenser tuned to the lower wavelength and connecting another tuned to the higher wavelength station.

The set I am now using works entirely from the mains except for a grid battery, and being of standard practice need not be described. The output is from three L.S.5.A. valves in parallel, and the H.T. is the full 240 volts less what is absorbed in smoothing, about 20 volts.

One feature of the installation which may be worth mentioning is the position of the loud speaker in the drawing-room. In my opinion horns are ugly and are best out of sight. I did not want a cabinet in this particular room. I preferred an R.K. moving coil, but it is a difficult instrument to mount in its baffle without being ugly, unless of course a really fine old cabinet is secured. As I was building a house the solution offered itself of putting it in the wall, and this was adopted. A ten-inch cone loud speaker was used. A hole twelve inches in diameter was cut in the wall between two rooms and lined with tinned iron and finished off with cement. The speaker is fixed in this, as the illustration shows. It has, of course, to be open at the back. This I thought at first might be a disadvantage as the loud speaker would necessarily have to be working in the two rooms at once, but in practice I have not found this a trouble. One of the rooms is a hall and not a sitting-room. The loud speaker could not be mounted in an outside wall, for the back being open the cone would get damp. I think the mounting in the wall is ideal. It is hardly noticed, and is not unsightly. It provides a very large baffle, which these loud speakers need to produce their best bass notes. There is, moreover, no cabinet booming or sympathetic vibration from the baffle which is so often noticeable with the R.K. in a box.



The loud speaker in the drawing room. The instrument—a Rice Kellogg moving coil—is mounted in the wall, which is lined with tinned iron and finished off with cement. Baffle vibration is entirely absent.

The individual control of each loud speaker for volume is very necessary. You cannot control the whole set without interfering with the volume at all loud speakers, and you may want silence momentarily or for some time at one speaker. Local individual control is afforded by a resistance varying with the loud speaker put across its movement or moving coil. In the case of the R.K. it is a ten-ohm rheostat of standard type.

"THE WIRELESS WORLD" BUYERS' GUIDE TO SETS.

Next week's issue will contain this annual feature. Readers desiring to select or make reference to specifications of any commercial set will find the Guide invaluable.

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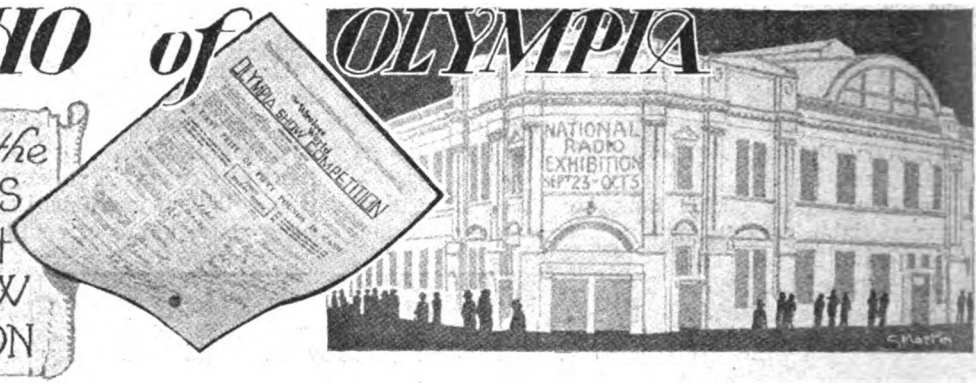
An ECHO of OLYMPIA

A Review of the APPARATUS Voted the Best in our SHOW COMPETITION



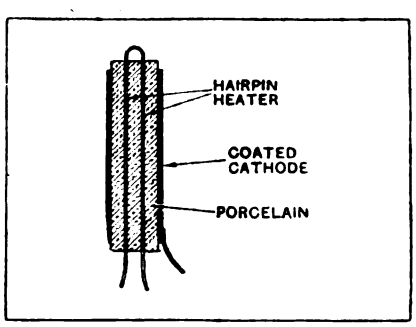
IN the following pages we illustrate and describe the apparatus which in the voting competition arranged by "The Wireless World" in connection with the Olympia Radio Show gained first place in the total of votes cast by our readers in each of the various classes into which we divided the Olympia Show exhibits as a whole. It will be recollected that readers were asked to vote for what they considered to be the outstanding single exhibit at the Show, and, in addition, to make their choice of apparatus in each of seven classes into which the exhibits at Olympia as a whole were divided. The classes were:—(1) Complete receivers of five valves or more. (2) Complete receivers of four valves or less. (3) Batteries of all kinds. (4) Mains supply units. (5) Loud speakers. (6) Valves. (7) Other apparatus not classified above; also amplifiers, component parts such as transformers, condensers, tuning coils, resistances, etc., etc.

The apparatus which gained these positions were, as already announced:—The outstanding single exhibit, the Mazda AC/SG valve, and in the various classes: (1) Burndept A.C.7 receiver. (2) Philips four-valve, all-electric receiver, No. 2,511. (3) Exide H.T. accumulator, Type WY.10. (4) Ekco combined A.C. eliminator. (5) Ferranti moving-coil loud speaker. (6) Mazda AC/SG valve. (7) Gambrell Novotone corrector. Elsewhere in this issue the announcement is made of the names of the readers of "The Wireless World" who have won the prizes in the ballot for their forecasts of the popular vote.

MAZDA A.C. SCREEN-GRID VALVE.

WHEN the screen-grid valve first made its appearance on the market somewhat wild claims were made concerning its performance as a high-frequency amplifier. Time proved, however, that as regards amplification little benefit was to be derived as compared with a well-designed balanced three-electrode valve. The reason for this was not far to seek. Stable amplification was limited to a comparatively low figure on account of the energy fed back through the anode-grid capacity of the valve.

Those who have built a set embodying the new Mazda AC/SG valve, which is a great advance over its predecessors, will agree that its position as winner both of class 6 and class 8 of the Competition is well merited. It is safe to say that with this valve a greater stage gain can be attained than with any other commercial valve existing. The inter-electrode capacity which has such an important bearing on stable amplification has been reduced to the remarkably low figure of 0.0045 $\mu\mu$F. by the expedient of arranging two screening grids in cascade. When extreme care is taken with external screening and when the tuning circuits are designed with low losses, a stage amplification of approximately 250 times can be obtained before the threshold of instability is reached. This performance is about six times better than that of the best neutralised triode. The valve is designed to be fed from A.C. mains, and has an independently heated cathode, but the heater consumption of 1 ampere is hardly in excess of the capabilities of the average L.T. accumulator, where the absence of lighting mains demands this form of L.T. supply.



The heater assembly in the Mazda AC/SG valve. The hairpin heater is dipped into liquid porcelain and a coated metal cathode is then arranged outside.

That the cathode has an equipotential surface (i.e., no voltage gradient) and no field around it, means that the electron flow is less restricted than in an ordinary filamented valve, and there is the further advantage in the valve under review of the "short-path" characteristic. The combined effect of these is a valve with an amplification factor of approximately 1,200 and an A.C. resistance of about 800,000 ohms under working conditions, giving a mutual conductance of 1.5 mA. volt.

In designing a suitable intervalve coupling for this valve one's thoughts naturally turn to the tuned transformer which has the advantage of preventing L.F. impulses from reaching the grid of the subsequent valve. To extract the maximum amplification from the valve in these circumstances it is necessary that the dynamic resistance of the primary of the transformer should be equal to the A.C. resistance of the valve, but up to the present it has

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An Echo of Olympia.—

not been found possible to design a coil with a dynamic resistance greater than about half the A.C. resistance of the AC/SG. This would mean a step-down ratio which is unfortunately inconvenient in that the screen-to-anode capacity which is shunted across the primary winding would cause unwanted resonance and curtailment of wave range.

A compromise has perforce to be effected in the use of a one-to-one transformer. Where selectivity must be of the highest order due to the presence of a local powerful transmission it may be necessary to remove primary turns and sacrifice part of the amplification. For instance, with a three-to-one step-up transformer of *The Wirless World* type having sixty-eight turns of 27/42 Litz on a 3in. former an amplification of 160 times will be possible, while with a one-to-one ratio transformer of the same type a stage amplification of over 350 could be obtained. The latter figure, however, exceeds the threshold instability amplification of 250 mentioned earlier, so that neutralisation would be necessary. In this connection the reader is referred to *The Wireless World* Record III Receiver[1], in which an unprecedented stage amplification averaging 500 was obtained using an earlier form of the Mazda AC/SG valve. The choke-fed tuned-grid circuit which is equivalent to a one-to-one transformer is also suitable, and was employed in "The Flat Dwellers' A.C. Three" receiver,[2] which had a measured stage amplification of about 225 times.

The constructional details of the valve are interesting—particularly the cathode assembly. Instead of a separate heater and insulator the heater is dipped into a liquid porcelain "slip" to become coated with an adherent insulator. The cathode —a metal tube coated with the oxides of barium and strontium—which is arranged around the surface of the porcelain, can therefore have a small diameter and be of considerable length resulting in the watts dissipation per centimetre being small. By this means the control grid is kept cool, and grid emission—one of the chief bugbears in A.C. valves—is prevented. The heater is bent into the form of a hairpin and is thus non-inductive; this, together with the equipotential cathode, assists in the prevention of hum.

In designing a receiver with a large stage amplification it is advisable to return the cathode to the centre of the heater winding of the transformer and to pay special attention to decoupling and metal screening in three dimensions. The optimum anode voltage is 150, the screen voltage about 60, and the control grid voltage a little under a volt. The 0.9 volt bias cell developed by Messrs. Siemens for *The Wireless World* is suitable. A remarkable property of the duplex screening grid is to restrict the screen current to a small fraction of a milliampere—in fact, conditions may arise in which the screen current is negative.

With the advent of Brookmans Park it should be pointed out that the signal voltage which may be impressed on the grid of one of these screened valves may cause an excursion into the lower bend and to the region of grid current. Not only does this state of affairs cause distortion but selectivity is adversely affected. The implication is a volume control between the aerial and the first valve.

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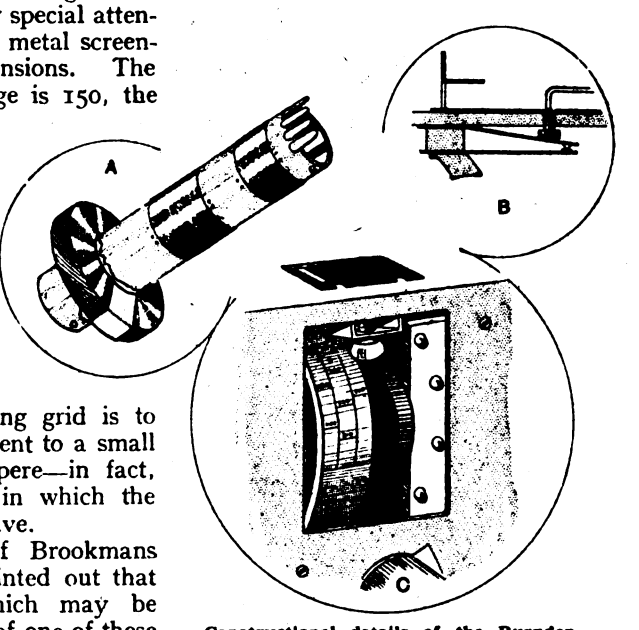
BURNDEPT A.C. SCREENED SEVEN.

THE Burndept A.C. Screened Seven has been specifically designed to meet the requirements of those who wish to receive broadcasting at a reasonable cost both as regards maintenance and initial outlay, and with the minimum of technical complication. Just as the Burndept Universal Screened Five may be regarded as a "sports" model for the enthusiast, so the A.C. Screened Seven fulfils the rôle of the "utility model," which can be relied upon to give a first-class performance in the hands of the layman.

By distributing the H.F. amplification over two stages it has been found possible with only one main tuning control to attain sufficient range and selectivity to guarantee the uninterrupted reception of all the stations worth receiving from a programme point of view. Under present conditions in the ether, this means a choice of at least ten or a dozen reliable alternative programmes from British and foreign stations.



Constructional details of the Burndep. A.C. Screened Seven. A, anode circuit inductance unit; B, gramophone pick-up contacts operated through an ebonite button by the wave range switch arm; C, calibrated slow motion drum dial and indicator lamp.

The standardisation of A.C. mains supply for both H.T. and L.T. current not only reduces maintenance costs to a negligible figure, but also ensures a generous and constant output to the loud speaker. The push-pull output stage is, in fact, capable of supplying a volume adequate for most domestic requirements with an ample reserve of undistorted acoustic power.

On the production side considerable ingenuity has been displayed in the design of the metal screening chassis

[1] See *The Wireless World*, September 4th and 11th, 1929.

[2] *The Wireless World*, May 1st and 8th, 1929.

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An Echo of Olympia.—

and the layout of parts. The A.C. Screened Seven is no mere adaptation of previous conventions in receiver design. Having settled on the functions which the receiver will be required to perform a completely fresh start has been made. Technical considerations have been studied in conjunction with production problems, with the result that the final design can be sold at a very reasonable price.

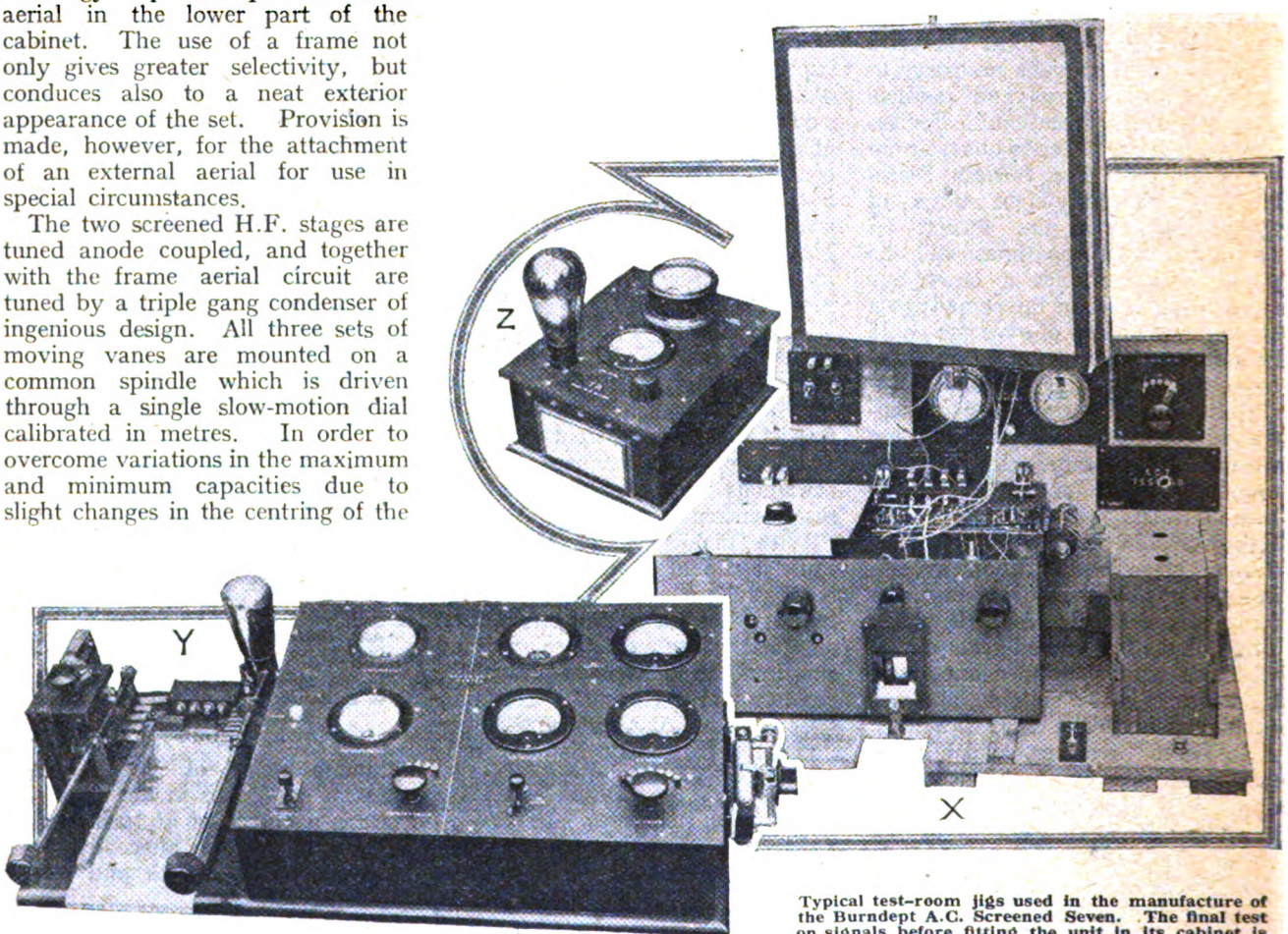
Energy is picked up on a frame aerial in the lower part of the cabinet. The use of a frame not only gives greater selectivity, but conduces also to a neat exterior appearance of the set. Provision is made, however, for the attachment of an external aerial for use in special circumstances.

The two screened H.F. stages are tuned anode coupled, and together with the frame aerial circuit are tuned by a triple gang condenser of ingenious design. All three sets of moving vanes are mounted on a common spindle which is driven through a single slow-motion dial calibrated in metres. In order to overcome variations in the maximum and minimum capacities due to slight changes in the centring of the moving vanes, double spacing has has been employed for both sets of plates. Accurate ganging is further simplified by dividing the wave range into three bands—two for medium waves and the third for long. A three-way rotary switch, with groups of contacts in each compartment of the condenser screening unit, short-circuits sections of the tuned anode and frame inductances not in use. The tuned anode coils are made by precision methods, and a continuous record in the form of a chart is kept showing variations in the inductance. The curve must fall between specified limits or production is stopped and the trouble investigated. Each section of the gang condenser is provided with small trimming condensers for bringing the minimum capacity up to the value for which the curvature of the vanes has been designed. In the case of the frame aerial circuit the trimming condenser is of slightly larger capacity, and is provided with a separate control on the front of the cabinet.

The H.F. stages are followed by an anode bend detector resistance-coupled to a first L.F. stage which is in turn coupled to the output valves through a Ferranti push-pull transformer. A push-pull output transformer feeds the double-diaphragm balanced armature loud speaker incorporated in the base of the cabinet, and terminals are provided for operating an external moving coil speaker if desired.

A gramophone pick-up can be connected to the detector input, and a fourth position on the wave range switch operates contacts which bring about the necessary changes in grid bias, etc. A system of resistances and condensers has been introduced at this point to suppress extraneous pick-up in the gramophone leads.

All supply currents and potentials for working the receiver are derived from A.C. mains through a rectifier unit connected to the receiver chassis



Typical test-room jigs used in the manufacture of the Burndept A.C. Screened Seven. The final test on signals before fitting the unit in its cabinet is carried out in jig X with the unit inverted and the loud speaker and frame aerial in the same relative position as in the final assembly. The output constants of the power unit are checked by means of the test panel Y; note contacts on extreme left for picking up connection with the terminal strips on the power unit. The unit Z is used for classifying and matching valves for the push-pull output stage.

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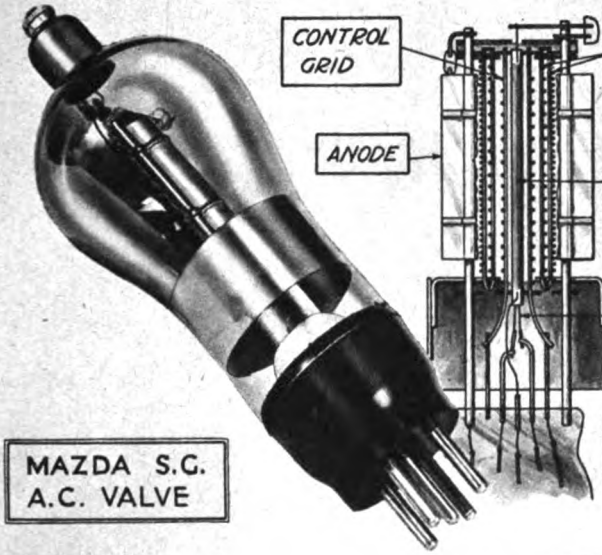
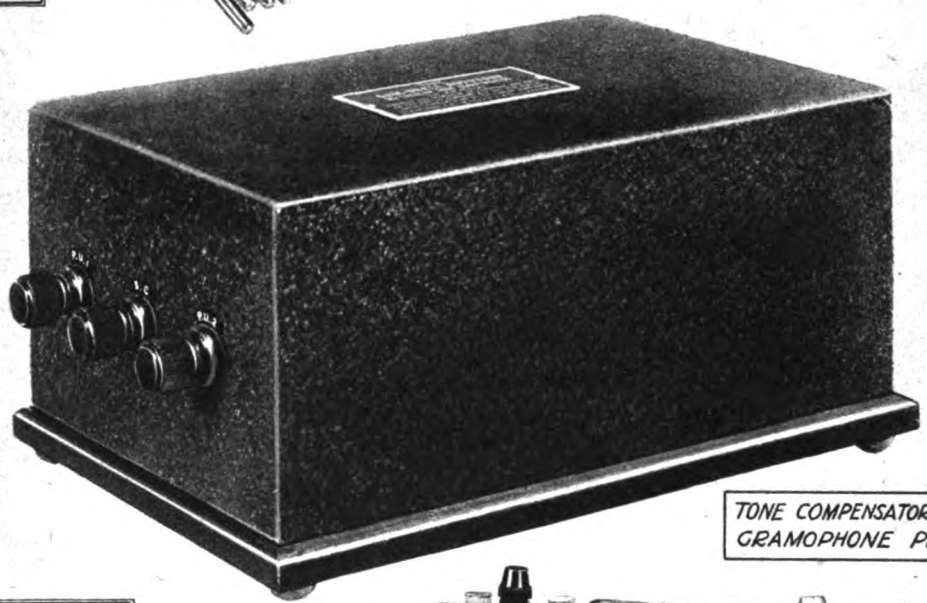


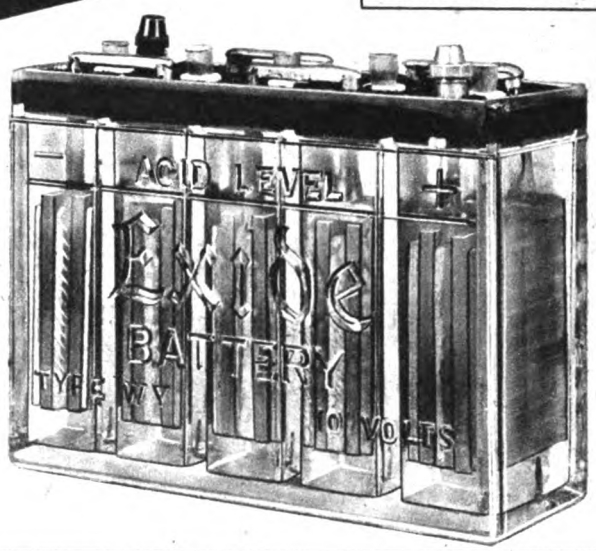
MAZDA S.G. A.C. VALVE

The Wireless World AND RADIO REVIEW OLYMPIA COMPETITION WINNING APPARATUS



TONE COMPENSATOR UNIT FOR GRAMOPHONE PICK-UPS.

GAM-BRELL NOVOTONE.



EXIDE H.T. ACCUMULATOR TYPE W.Y.10.

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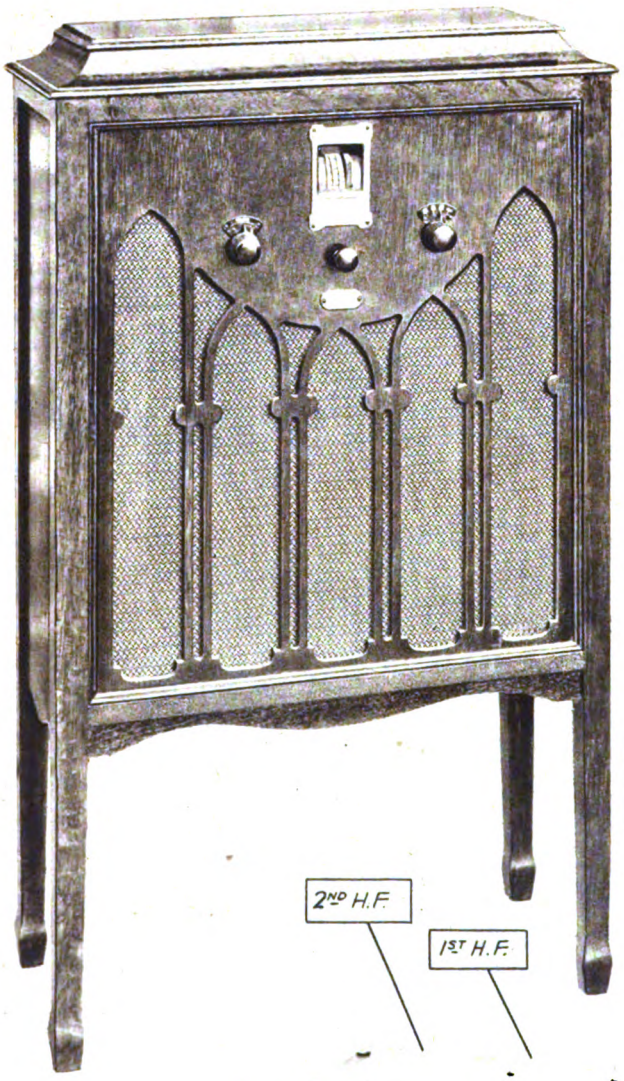

BURNDEPT A.C.
SCREENED SEVEN

TRIPLE GANG CONDENSER WITH DOUBLE SPACED VANES

WAVE RANGE SWITCH OPERATING IN THREE COMPARTMENTS

AERIAL TRIMMING CONDENSER

2ND H.F.

1ST H.F.

PUSH-PULL OUTPUT VALVES

POWER RECTIFIER

1ST L.F.

DETECTOR

RECEIVER UNIT

ELIMINATOR UNIT

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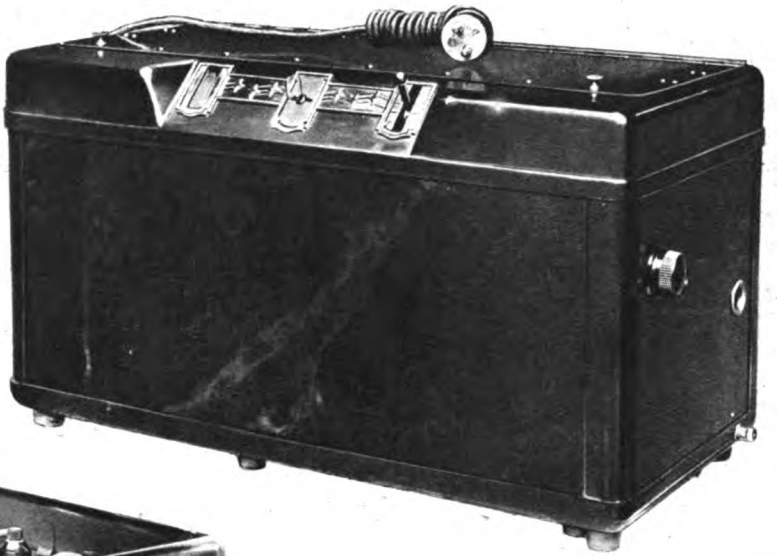
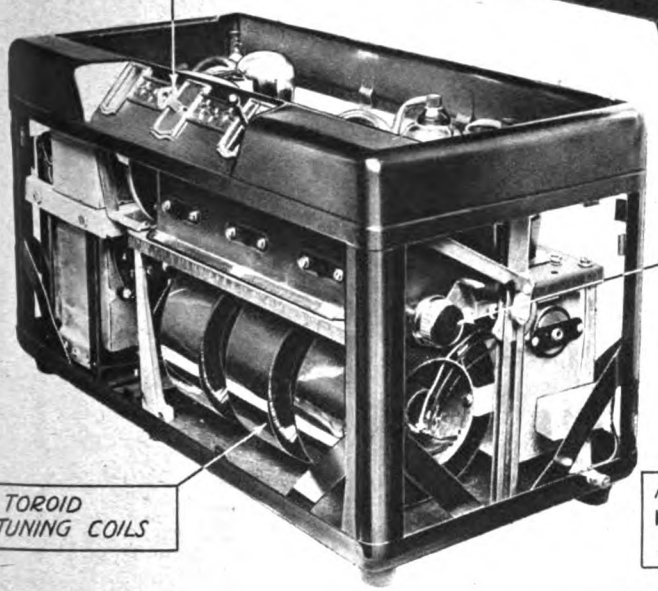
PHILIPS FOUR-VALVE ALL-ELECTRIC RECEIVER TYPE Nº2511.





LOCKING DEVICE

TUNING KNOB.

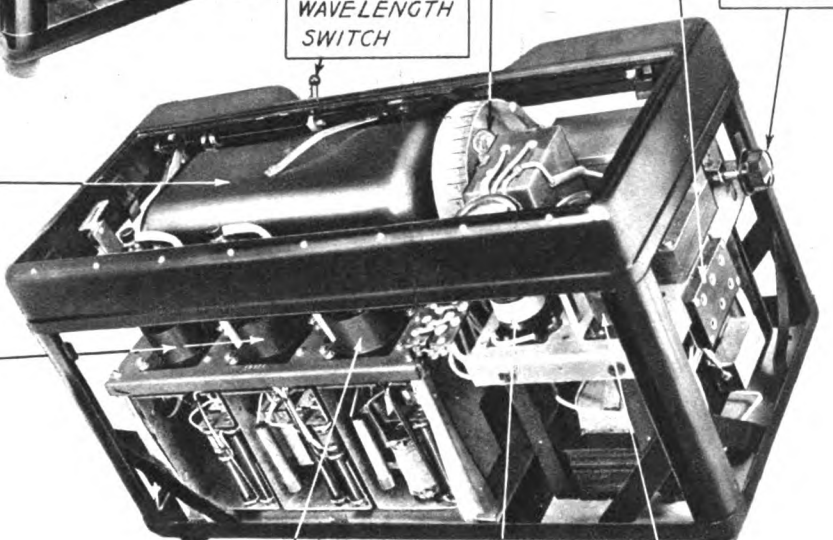
SOCKETS FOR MOVING COIL, CONE AND PICK-UP

ILLUMINATED TUNING DIAL

VOLUME CONTROL

MAINS AND WAVE-LENGTH SWITCH

TOROID TUNING COILS



GANGED CONDENSERS

2-A.C. SCREENED GRID H.F. VALVES

DETECTOR

SUPER PENTODE

RECTIFIER

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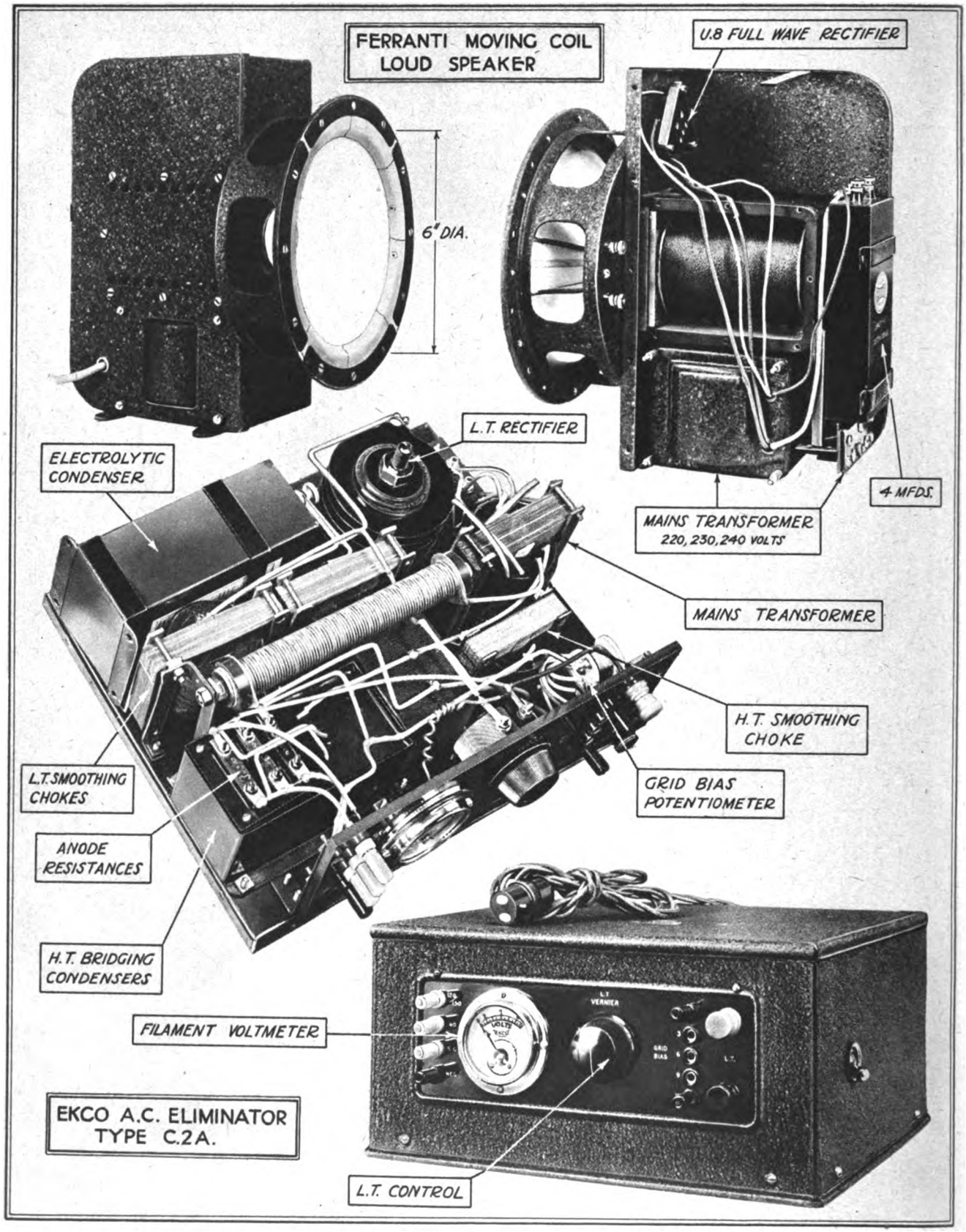

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An Echo of Olympia.—

through an eight-contact terminal bridge. The H.F. detector and first L.F. valves have indirectly heated filaments working at 4 volts, while the push-pull power valves have directly heated filaments at 6 volts. The difference in the voltage of the two filament circuits is made use of in illuminating the wavelength dial lamp, which also serves to indicate that the main current is switched on. The anode current is supplied through a full-wave valve rectifier, while grid bias is derived from a separate Westinghouse metal rectifier. The grid bias to the output valves is adjustable.

The receiver is absolutely silent in operation, and there is no trace of 50-cycle A.C. hum. The push-pull output helps considerably in this direction, as any residual hum after smoothing is cancelled out in this stage. The two P.625A valves are capable of an undistorted output of 1.5 watts, which is more than sufficient for ordinary domestic requirements. The quality with the standard loud speaker incorporated in the cabinet is good, and with an external moving coil it is excellent. The range and selectivity are comparable with a really first-class portable, and in the London area no trouble is experienced in receiving ten or a dozen foreign stations, including those on long waves. By close tuning of the dials this number could be considerably augmented. Daventry 5GB is quite free of any background from Brookmans Park, and there is no trace of the latter transmission on 261 metres, the wavelength allotted to the alternative station. The single dial tuning is, of course, simplicity itself, while the volume control, which takes the form of a potentiometer controlling the grid bias to the first H.F. valve is smooth in operation.

Through the courtesy of the chief engineer we have had an opportunity of seeing the methods employed in the production and testing of the A.C. Screened Seven. Press work plays an important part, not only in the formation of the metal chassis but also in the construction of small parts such as valve holders, and special plant has been laid down for dealing with the larger portions of the screening system. An imposing array of special test jigs have been developed for checking the electrical constants of such components as coils, variable condensers, and power transformers, while a special unit is used for matching the push-pull power valves. The final test on the complete chassis is made in an inverted position on a special jig with a standard loud speaker and frame aerial mounted above the chassis in the same relative position they would occupy in the cabinet. At this stage final adjustments are made to the trimming condensers of each tuned stage, and check readings are made of anode currents, etc. Each unit is required to pass further tests on actual signals, and is then ready for packing and despatch.

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PHILIPS FOUR-VALVE RECEIVER. Type 2511.

NO possessor of this type of receiver will wish to disagree with the findings of the ballot in the class for receivers with less than five valves. The interest in the Type 2511 at the Philips stand this year gave a sufficient clue that it was a likely winner. In that it was the first all-mains-operated four-valve set, all-metal built, and constructed on mass-production lines, it rightly deserves a place among the winning sets. Its unique design, combined with remarkable performance, has earned the enthusiasm of the discriminating amateur to whom, this, the first technical description, may be of special interest.

Nothing of a technical nature is revealed externally, and the metal-bound cabinet with its bakelite panels and rounded corners will not offend in any surroundings, it being neither ornate nor ugly. Absence of complex controls is another of its good features, and while it is not disguised so as to lose its radio identity, the bewildering effect so often produced by a number of operating knobs is avoided. The finish is one which will not readily deteriorate, there being neither bright parts nor polished panels. There are but three controls, a single-geared tuning knob, a wave-change switch and a volume adjuster. Instead of the rotary controls appearing on the front panel as is so often the case, they are conveniently placed at opposite ends of the cabinet in order to provide convenient operation.

Technical knowledge is no aid to getting the most out of the set, as it is only necessary to rotate the single control tuning with one hand while the other hand maintains a critical regulation of volume. Test reveals that stations are to be found at every few degrees on the drum indicator. A transparent scale with lamp and hair line appears in the centre of the instrument behind a window on a narrow top bevel. The single lever switch which gives the two-wave ranges has, in addition to an "off" position, a setting that throws the gramophone pick-up into circuit. There is also a key which on one turn locks the lid and with a second turn locks the lever switch as well, so that the set cannot be turned on, while by means of an automatic locking bar the lid cannot be raised except when the switch is turned to the "off" position.

On raising the lid little is revealed other than the fact that there are two screen-grid stages with S4V valves, an indirectly heated detector—the 154V—power pentode, the new PM24A with a working anode potential of 300 volts and a Philips full-wave rectifier type 2505. Beyond this everything is sealed, though a good deal of information concerning the interior apparatus was to be gleaned from the exhibition model in which the side panels had been removed.

The three tuning condensers being ganged on to a common shaft need compensating for small capacity differences in the associated inductances and this is probably carried out by three screws, the heads of which are exposed through the screening and their settings held by red sealing wax. These screws must adjust auxiliary condensers in parallel with the tuning units and in that they are used to bring the stray parallel capacities up to a given value it becomes necessary that the variable condensers follow a logarithmic law and a simple test with a wavemeter confirms the use of log scale condensers.

Three sets of tuning coils of the

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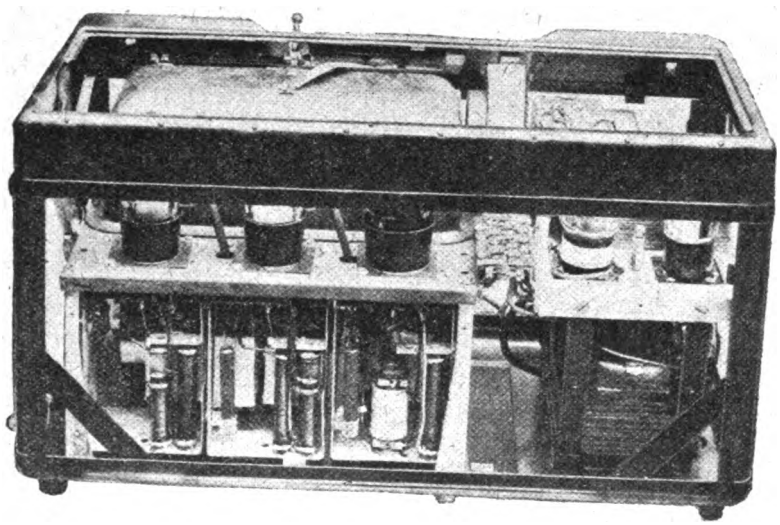
An Echo of Olympia.—

toroid form are used in both the short- and long-wave sections and are assembled concentrically. As only three wires could be seen passing from each pair of coils it would seem that the circuits are tuned anodes, and while the form of inductances employed is known to be not the most efficient it is probable that with the aid of a small interelectrode capacity that the working condition approaches but never reaches the oscillating point. By this means the stage gain is particularly high and the overall resonance curve of the combined circuits would seem to be one which combines selectivity with quality. Bakelite formers give support to the toroid inductances and in that spaces exist between these concentric supporting tubes, complete screening must pass between the individual stages when the receiver is completely assembled. Change of wave range is probably effected by simply short circuiting the long wave coils and a bar switch connected by links to the front lever passes right along the tuned stages.

Resistances, wound mostly on glass tubes combined with small cylindrical condensers and large capacity condensers of the metal box type, are to be seen associated with each stage so as to give the necessary anode, screen and grid biasing potentials while avoiding feed-back through the common H.T. source in a manner no doubt very similar to that described not long ago in the pages of this journal.

The volume control knob is to be found at the eliminator end of the receiver and would seem, therefore, to be associated with the L.F. stage with which the eliminator appears to be combined, suggesting post-detector control. The instructional booklet, however, recommends the use of an external volume control when using the gramophone pick-up. This seems to make it clear that the volume control in the set precedes the detector. The component used for volume control is a wire-wound potentiometer giving a smooth and uniform regulation and is, no doubt, associated with one of the resistances used for grid biasing. Owing to the high anode voltage of the output valve an output transformer is fitted and by the use of two secondary windings high or low resistance loud speakers can be used. A tone-correcting condenser can be introduced and is combined with the two-pin loud speaker connector.



Philips receiver with side panel and screening covers removed. Biasing and anode feed resistances are associated with the tuning equipment contained in the screening compartments.

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EXIDE W.Y.10 H.T. ACCUMULATOR.

THIS is the latest addition to the Exide range of H.T. units, and made its first appearance on the occasion of the recent Radio Exhibition at Olympia. In designing this model, the Chloride Electrical Storage Co., Ltd., would appear to have appreciated the need for a reasonably priced unit, robust in construction and of sufficiently large capacity to cope successfully with the demands made on it by the average domestic receiver. In addition it performs this function with the minimum of attention, and, where facilities are available for trickle charging, provides a trouble-free H.T. supply for a lengthy period.

The W.Y.10 is a 10-volt unit consisting of five cells built into a multi-compartment glass container, each cell having a capacity of 7,000 milliampere hours. Assuming a normal discharge of 25 mA., a useful life of 280 working hours could be obtained on one charge. In general, the battery would be recharged about once every fortnight or so, as this will keep it in better trim than less frequent attention.

Each cell is fitted with an ebonite lid, sealed in position, a feature which materially assists cleaning, and at the same time makes for more robust construction. Inter-cell leakage is minimised by extending the moulded partitions to the top of the glass container and carrying the lead bridge pieces over the tops of the sealing lids. The two end lugs, carrying the positive and negative terminals, are provided with projecting pieces which fit into slots cut in the ebonite lid, holding them rigidly in position and thus preventing undue strain on the lugs, and incidentally the plates, when the terminal heads are screwed down tight.

These terminal heads are non-interchangeable, being fitted with screw shanks of dissimilar size, and to assist in distinguishing them the positive is hexagonal in shape while the negative is round with a milled edge. Batteries are usually located in an out-of-the-way corner, not too well lighted, so that the advantage of being able to distinguish the positive from the negative without recourse to illumination will be appreciated.

Since the function of an accumulator depends on electro-chemical action, it will be realised that the most important feature is the plates.

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An Echo of Olympia.— Furthermore, the design of these will be governed by the nature of the work the cells are required to perform.

In the Exide cells the plates are made of antimonial lead cast in grid form with the active material applied in the form of paste. The active material only does the work, the lead grid being a retainer and conductor. Porous ribbed wood separators fill the space between the positive and negative plates, and so prevent short-circuiting. This type of assembly is adopted in the W.Y.10 model.

The well-merited popularity enjoyed by Exide batteries among wireless users is the outcome of forty years' experience in the manufacture of the lead type accumulator. Research work is continuously going on with a view to future improvements, and every new idea brought to the notice of the company is very carefully examined.

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"EKCO" ELIMINATOR MODEL C.2A.

THIS unit is one of a series designed by Messrs. E. K. Cole, Ltd., to replace all batteries, including grid bias, and supply the receiver with power drawn from the electric mains. The model C.2A is for use on alternating current supplies of from 40 to 100 cycles periodicity, and can be obtained to suit all recognised standard voltages between 100 and 250. Since it is intended as a substitute for batteries, no alteration to the set is required.

The unit consumes 12 watts per hour, so that the running cost per 1,000 hours, assuming 6d. per unit as the price of electric current, would be approximately six shillings. Now, 1,000 hours represents, on an average of twenty-five working hours per week, a matter of forty weeks, so that running costs represent a very small fraction of the electricity account.

The model C.2A gives three H.T. voltages—one for the priming grid in screen-grid valves, a 60-volt supply for leaky grid detector valves, and 120-150 volts for the remaining stages in the receiver. A current of 20 mA. may be drawn from this tapping. Provision is made for low-tension current at 2, 4, or 6 volts, from 0.2 amp. up to 0.5 amp. In addition, grid bias from 1.5 volts to 12 volts, in five steps, is available.

Half-wave rectification, using a Westinghouse metal rectifier, is adopted for the H.T. supply, and a single choke and generous-sized condensers take charge of the smoothing. The detector voltage is fed through a series resistance, and a potentiometer arrangement, obtained by connecting two resistances in series, provides the voltage for the priming grid in the screen-grid H.F. valve. Grid bias is derived from a tapped resistance between the H.T. and the transformer.

For the L.T. supply a Westinghouse full-wave (bridge-type) metal rectifier is used. Two smoothing chokes of generous size and special large-capacity electrolytic condensers completely remove all ripple from the rectified A.C., and deliver to the L.T. terminals a steady current for the filaments of the valves. A variable rheostat controls the output, and a voltmeter gives visual indication of the voltage across the L.T. terminals.

The unit is enclosed in a stout sheet iron container with a brown crystalline finish. A small terminal is fitted for earthing the case, thus conforming to the recommendations of the I.E.E. as regards safety measures for domestic mains-operated devices.

A length of flex, terminating in a lamp adaptor, serves to connect the unit to the nearest convenient lampholder. According to the makers' instructions, the switches on the set should be left permanently in the "on" position. Switching on and off should be carried out by the mains switch on the unit, or the switch controlling the light point to which the unit is attached. By following this advice the condensers in the mains unit will not be left in a charged state, and it will be impossible to receive a shock, due to the retention of current in the large smoothing condensers, should, at any time, the wiring in the receiver require attention.

FERRANTI MOVING COIL LOUD SPEAKER.

OF the instruments which made their first appearance at Olympia the Ferranti loud speaker attracted its full share of attention. Here we have the final link in the endeavour made by the Ferranti Company to produce quality reception. Their careful study of circuit and transformer design in this connection gives to them the highest qualification for the production of a moving-coil loud speaker.

Models are available for both A.C. and D.C. field excitation, and in the former case the transformer and valve rectifier are carried in the loud speaker housing. As the valve used is a U8, a generous magnetising wattage is available which, combined with a small gap, produces a high flux density. A substantial copper plate screens the magnet winding from the moving coil as well as giving support to the centre pin. Instead of the field magnet taking the customary form of a hollow cylinder it is made of flat metal and is "U"-shaped. Ample cross section is obtained by this design with the added advantage that the heat produced in the magnet winding is carried away by the free circulation of air.

Eight segments of supple leather are assembled to give support to the cone, this being 6in. in diameter, a dimension which, it is to be noted, is slightly less than the customary one of 7in. or so. Centring is effectively carried out by a pierced card centred on the pole. A pressed metal cylinder supports the diaphragm, while a new departure in loud speaker construction generally is produced by metal stampings forming a housing enclosing field magnet and rectifier.

It is needless to add that by the simple process of aural test the performance of this new Ferranti product gives it a leading position among moving-coil loud speakers. It is fortunate that the popular vote should this year endorse the moving coil at a time when its general adoption is so rapidly growing.

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GAMBRELL NOVOTONE.

IN spite of the enormous advance in the quality of gramophone records produced by electrical processes few will deny that broadcasting at its best still keeps a fair margin of lead over the gramophone in the matter of quality. Limitations in loud speakers and amplifiers, of course, affect both systems of reproduction, but the necessity for restricting amplitude at low frequencies definitely places the gramophone record at a disadvantage. Most modern pick-ups show a rising characteristic from 250 cycles downwards, but the compensation is in most cases inadequate and the lower frequencies are not present in their proper proportion. Similarly, there is in many cases a lack of brilliance in the upper register.

In the "Novotone," designed for Messrs. Gambrell Radio, Ltd., by Dr. N. W. McLachlan, we have a device which adequately compensates for these deficiencies in recording, and in the characteristics of pick-ups, amplifiers and loud speakers. For obvious reasons the exact nature of the device is not

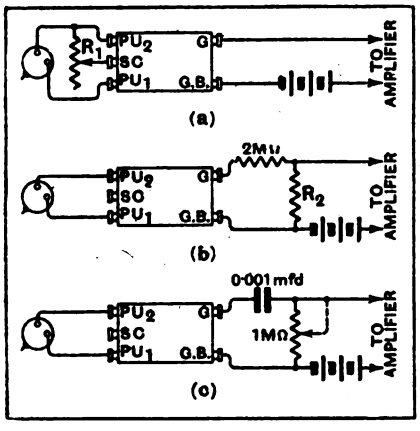

Fig. 1.—(a) Connections of scratch filter resistance R_1. (b) Potentiometer output circuit for reducing volume level. (c) Output circuit for reducing amplitude of low notes in special circumstances.

divulged, but its function will be properly understood if we regard it as a step-up transformer with a rather special frequency characteristic. The curves indicate that there is a general raising of the level of the input from the pick-up, while there is a marked increase in the amplitude of notes below middle C and another increase in the higher frequencies reaching a maximum in the vicinity of 4,000 cycles.

The rate of increase in amplitude of the low notes with decreasing frequency has been carefully calculated in relation to recording deficiencies and other practical considerations, with the result that the low note compensation will be found to be sensible correct for most exist-

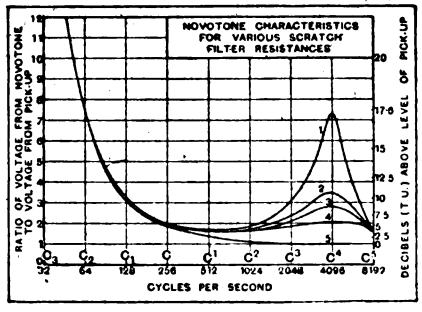

Fig. 2.—Curves for the circuit of Fig. 1(a) showing effect of scratch filter resistance R_1. Values of R_1 are as follows: 1, infinity (open circuit); 2, 50 ohms; 3, 30 ohms; 4, 15 ohms; 5, 0 ohms (short circuit).

ing records, pick-ups and loud speakers. Record surface scratch, however, sets a limit to the useful increase in amplitude at high frequencies, and the degree of scratch varies with different records. Accordingly, provision has been made for effecting a compromise between high-note amplification and scratch. This is effected by connecting a 50-ohm rheostat (R_1, Fig. 1 (*a*)) across terminals SC and PU_2; as the resistance is reduced in value, so the high note amplification, and hence scratch, is reduced. The effect of the resistance R_1 on the Novotone characteristic is clearly indicated in Fig. 2.

Many moving-coil loud speakers show a marked resonance in the region of 50-100 cycles. In these circumstances the increase in amplitude at low frequencies due to the Novotone would produce unpleasant results, if not actual damage, to the loud speaker. This difficulty is easily overcome by connecting a 0.001 mfd. condenser and a 1-megohm resistance between the Novotone and the grid and filament of the first amplifier as shown in Fig. 1 (*c*). The effect on the characteristic is shown in Fig. 3 (A).

Where the Novotone is to be used in conjunction with existing amplifiers the general increase in voltage may result in overloading. A potentiometer arrangement must then be inserted as in Fig. 1 (*b*). It is important that the total resistance across terminals G and G.B. should be not less than 3 megohms. One resistance may conveniently be given a value of 2 megohms, and the other, R_2, be given any value from 1 megohm upwards, depending on the volume required. Curve B (Fig. 3) was taken with 1 megohm in the position R_2. The dotted line is curve 1 of Fig. 2 drawn for comparison to the same scale.

The Novotone was tested under working conditions with a four-pole change-over switch arranged to connect the pick-up direct to the amplifier for purposes of comparison. Apart from the general increase in volume, which is almost equivalent to adding a further valve, the effect of introducing the Novotone is most striking. On orchestral records it is like switching on the double basses, while the pedal and bass notes of the organ and piano are reproduced with a richness and volume closely

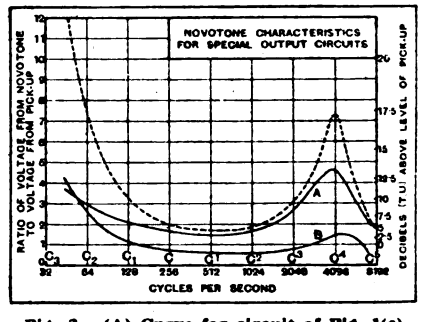

Fig. 3.—(A) Curve for circuit of Fig. 1(c) showing reducing in amplitude at low frequencies. (B) Curve for circuit of Fig. 1(b) showing general reduction in volume. The dotted line is curve (1) of Fig. 2 reproduced for comparison.

approximating to the original. The effect of the scratch filter and the special output circuit for modifying the low note amplification are also clearly demonstrated by the change-over switch arrangement.

There can be no doubt that anyone who has heard the Novotone demonstrated in this way would from that time onwards cease to be satisfied with gramophone reproduction by ordinary methods.

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CURRENT TOPICS

Events of the Week in Brief Review.

HENDON'S HOOK-UPS.

The Hendon Borough Council has decided that new houses on the Clitterhouse Estate are to be provided with hooks fixed in the gutter boards for the suspension of wireless aerials. Prospective tenants will be informed that, in the interests of tidiness, aerials will be permitted only if the hooks are used.

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AMERICA'S "FINEST PICK-UP" FROM HOLLAND.

For the first time in radio history a transmission from Holland was rebroadcast in the United States on October 26th. For forty-five minutes, beginning at 12 noon (E.S.T.) thirty stations associated with the National Broadcasting Company gave listeners a Dutch musical programme sent out from Huizen, PHI, operating on 16.88 metres, with a power of 40 kilowatts. The event was acclaimed as "the finest pick-up of a foreign programme ever accomplished in the United States."

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WIRELESS ABSOLVED.

The fallacy that wireless affects the weather has been given the *coup de grâce* by the French Academy of Sciences, which has endorsed the statements of M. Sanson, meteorologist of the Seine-et-Oise Department, who says: "The development of wireless broadcasting has produced absolutely no effect upon our climate in the past 20 years."

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THREAT TO INDIAN "PIRATES."

Radio "pirates" in India are shortly to have the shock of their lives, according to the Calcutta *Statesman*, which reports that the Post Office is about to initiate a campaign against the 10,000 persons in Calcutta alone who are known to be listening without licences. Hitherto, it is stated, the Post Office has been hampered by doubts about the exact legal position, but these have been entirely removed as a result of a case in the Alipore Court in which a "pirate" of high social standing has been fined 50 rupees, or in default, a month's imprisonment.

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HIGH-POWER BROADCASTING IN I.F.S.

It is understood that the Irish Free State Government will shortly invite tenders for the construction of a high-power broadcasting station with a service area covering the whole country. Although many recent contracts for electrical work in Ireland have gone to Swedish firms it is understood that the authorities are exhibiting a preference for British plant.

OFF DUTY DELIGHTS.

"La Maison des Gardiens de la Paix," a new home for the Paris gendarmes, has been equipped with a broadcast receiver, headphones being available for each bed.

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ESPERANTO.

The 22nd Universal Congress of Esperanto is to be held in Oxford during the first week of August, 1930. Methods will be considered for extending the use of Esperanto in broadcasting.

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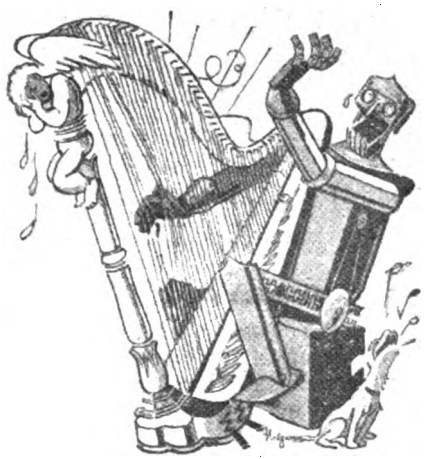
FRENCH PATENTS WARNING.

Bearing the title "For the Protection of the French National Market," a notice has been issued by the Compaigne Générale de T.S.F. Paris, declaring that no licence has been accorded to any foreign firm permitting the importation of wireless



THE ROBOT ENTERTAINER. A figure symbolising, in the eyes of the American Federation of Musicians, the "mechanical music" of broadcasting, the gramophone and the "talkies." The viewpoint of the professional musician is discussed in this week's Editorial.

apparatus employing the company's patents or those of the Société Française Radio Electriqué (Radiola), La Radiotechnique, G.E.C., Marius Latour, Bethenod, de Belleseize, Marconi, Telefunken, A.E.G., Siemens Halske, and Western Electric.

Traders are consequently warned that any infringement will lead to prosecution.

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G.E.C. v. MARCONI'S.

On Wednesday last, in the Chancery Division, Mr. Justice Eve gave judgment in favour of the General Electric Co. in cases brought by that company against Marconi's Wireless Telegraph Co. and Marconi's and the Marconi Osram Valve Co. respectively, on the question of whether the working agreement between the companies was coterminous with the ten years' lease of the G.E.C. valve factory at Brook Green.

His Lordship said the agreement was indefinite and was unlimited as to time. There was not a word in the document to indicate that any of the obligations undertaken by the contracting parties outside those embodied in the lease were to subsist only so long as the lease was running. The applicant company was, therefore, entitled to a declaration accordingly. The costs must be paid by Marconi's.

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NEW RADIO ERA FOR FRANCE?

Strong condemnation of State methods of handling broadcasting in France was contained in a speech delivered by the new Postmaster-General, M. Germain-Martin, a few days before he took office, writes our Paris correspondent. Speaking as a private individual, M. Germain-Martin deplored the evils of Post Office monopolies, which have proved so detrimental to private radio and the wireless trade. It is hoped that under the new Postmaster-General's guidance the forthcoming radio bill regularising French broadcasting will shortly become law.

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YOUR WIRELESS DIARY.

Every amateur must have wished at some time or another that he could carry a fund of wireless data "in his head." This being impossible in the majority of cases, the best substitute is a handy compendium of facts such as *The Wireless World* Diary and Note Book for 1930, published by *The Wireless World* and Messrs. Charles Letts and Company. The special features in the edition just published include: (1) Summary of regulations relating to amateur transmitting and receiving licences; (2) conversion tables (English measures to metric, etc); (3) the broadcasting stations of Europe, together with the principal short-wave stations; (4) typical wireless receivers and eliminators, with fourteen different circuits; (5) inductance, wavelength and capacity values; and (6) valve data, giving characteristics of standard valves.

Copies of *The Wireless World* Diary can be obtained from leading booksellers and stationers, or from the publishers, Iliffe and Sons Ltd., Dorset House, Tudor Street, London, E.C.4. The price, with cloth cover, is 1s. (postage 1d. extra), or with leather cover, pencil and season ticket window, 2s 6d., postage 1d. extra.

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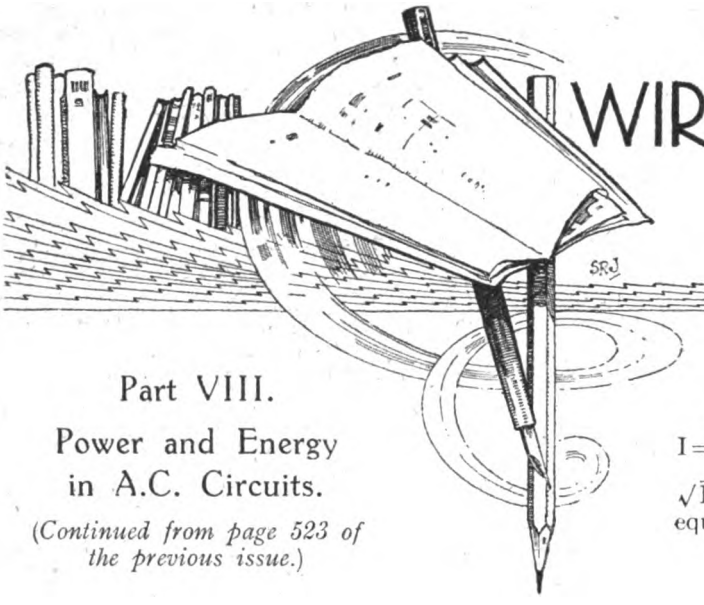

WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

Part VIII.

Power and Energy in A.C. Circuits.

(*Continued from page 523 of the previous issue.*)

IT will be remembered that, relating to alternating currents, the power absorbed by a simple resistance was found to be equal to the product of the R.M.S. values of the current and voltage, whereas for a pure inductance the average value of the power consumed was nil, no matter what the values of current and voltage might have been. In the former case the current and voltage were in phase, and in the latter 90° out of phase. It would seem reasonable to infer, then, that for a coil possessing both resistance and inductance, where the angle of lag of the current behind the voltage is between zero and 90°, the power absorbed will be somewhat less than the product of current and applied voltage.

Power and Angle of Lag.

This is actually the case, and so it is very important that we should know exactly how to determine the power in terms of the voltage, current, and angle of lag. Fig. 1 is a reproduction of Fig. 2 of the previous instalment, where (a) represents a coil of inductance L henrys and resistance R ohms, and (b) represents the equivalent circuit as explained previously.

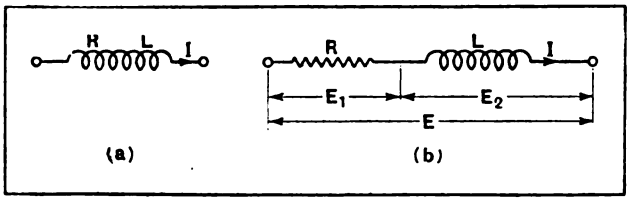

Fig. 1.—(a) Coil of resistance R and inductance L. (b) Equivalent circuit.

When a current is passed through the circuit, heat is generated in the resistance but no power is taken by the inductance. Thus the power taken by the coil (a) is exactly the same as the power taken by the resistance portion of the equivalent circuit (b), and can therefore be determined very easily. Let I amperes be the R.M.S. value of the current; then the average power in the resistance, and therefore in the whole circuit, is given by $P = I^2R = I \times IR$ watts. But we have already seen that for an inductive resistance the current is given by $I = \frac{E}{Z}$ amperes, where E is the applied voltage and $Z = \sqrt{R^2 + (2\pi fL)^2}$ is the impedance. Thus the power equation may be expressed in the form

$$P = \frac{E}{Z} \times IR,$$

or

$$P = I\frac{R}{Z} \text{ watts.}$$

Power Factor of a Circuit.

This result shows that for an inductive coil the power is not given by merely multiplying the amps. and volts together; we must also multiply by the factor $\frac{R}{Z}$ if we want the true power consumed by the coil. Now $\frac{R}{Z}$, the ratio of resistance to impedance, is obviously less than 1, because Z is the combination of both the resistance and the reactance, and therefore the power in an inductive circuit is actually *less* than the product of amps. and volts. The product EI is only the *apparent power*, and the factor $\frac{R}{Z}$ by which we have to multiply it to give the real power is called the *power factor* of the circuit. The apparent power EI is expressed in *voltamperes*, not watts; but the true power is in watts.

We can conclude, then, that for any circuit in which the current and voltage are out of phase the power consumed is less than their product and a power factor must be used.

For the particular type of circuit depicted by Fig. 1 the power factor is given by $\frac{R}{Z}$, but there are other types of circuit having an angle of phase difference between the current and voltage waves, and therefore also having a power factor less than unity, but not given by $\frac{R}{Z}$. So we must express the power factor in a general way which can be applied to any circuit.

If we refer to the impedance triangle for the circuit

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of Fig. 1, given in Fig. 2, we see that $\frac{R}{Z}$ is the cosine of the angle of phase difference between the current and the voltage, denoted by the angle ϕ of the triangle. So for any circuit whatever, the power factor is the cosine of the angle of phase difference, and the general expression for the power in an A.C. circuit becomes

$$P = EI \times \cos \phi \text{ watts.}$$

The previous discussions on the two special circuits containing resistance only and inductance only respectively enable us to visualise clearly what is happening in the present circuit where both resistance and inductance are present simultaneously. In the pure resistance circuit the whole of the energy put in is converted into heat and cannot be recovered, whereas in the circuit possessing inductance only any energy put in is stored in the magnetic field and the whole of it is recovered when the field collapses. Obviously in the combined circuit both of these effects will be present and the average power *must* have a value lying somewhere between zero and the product of amps. and volts.

During the time that the current is building up from zero to the maximum value some of the energy being put into the circuit is converted into heat in the resistance, the remainder going into the magnetic field as stored energy. During the next quarter cycle, when the current is falling again from the maximum value to zero, energy is being withdrawn from the field in the usual way, *but heat is still being generated in the resistance,* so that only part of the energy coming from the weakening field is given back to the source of supply. Nevertheless, we do get some of it back, and this explains the reason for the true power consumed being less than the product of current and voltage. A certain amount of energy is given to the circuit during the first quarter cycle of current, but a *portion* of this is recovered during the next quarter cycle, and so on.

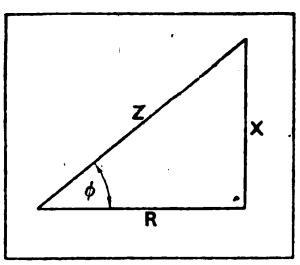

Fig. 2.—Impedance triangle for circuit of Fig. 1. The power factor of the circuit is $\frac{R}{Z}$ or $\cos \phi$. $X = 2\pi fL$ and $Z = \sqrt{R^2 + X^2}$.

Mechanical Illustration.

A frictionless crank and piston arrangement was cited for illustrating the action of a coil having inductance only, the whole of the energy used in accelerating the piston over the first half stroke being given back to the crank during the second half stroke as the piston was being retarded. This analogy can be extended to meet the conditions existing in a circuit with both resistance and inductance by taking friction into account.

Suppose that there is a considerable frictional resistance to motion existing between the piston and the cylinder wall. Over the first half stroke, as the piston is gaining velocity, the crank pin has to exert a force sufficiently great both to overcome the friction and to accelerate the mass of the piston. The energy used in overcoming the friction is converted into heat, raising the temperature of the piston and cylinder, the remainder being stored in the moving mass as energy of motion or kinetic energy. During the second half stroke, when the piston velocity is decreasing, the stored kinetic energy is given up by the piston as before, but there is still the frictional force to be overcome, with the result that only part of the kinetic energy is recovered and given back to the crank.

It will be seen that the analogy chosen to represent the happenings in our inductive circuit is very complete. Further consideration will show that even the phase relationship existing between the alternating force on the piston rod and the velocity of the piston is the same as that between the current and the voltage in the circuit. In future work we shall always liken inductance to inertia or mass and electrical resistance to frictional resistance. Further, it will be shown that capacity can be likened to elasticity or spring action, and the combination of these three will prove of great value in illustrating the behaviour of oscillating circuits.

Numerical Examples.

An inductive coil is one of the most important circuit components used in radio circuits, and therefore it will be helpful to give at this juncture one or two numerical examples on the calculation of current and power consumed by an inductive coil when an E.M.F. of known voltage and frequency is applied to it. In the majority of cases a D.C. component of current will be present as well as the A.C., but for the moment we shall assume that we are dealing with pure alternating current. Accordingly let us consider a coil whose resistance and inductance are known to be 10 ohms and 0.5 henry respectively, and that we require to find the current and power consumed when 100 volts R.M.S. value at a frequency of 50 cycles per second is applied to its terminals. At 50 cycles the reactance is $X = 2\pi fL = 2\pi \times 50 \times 0.1 = 31.4$ ohms. The impedance of the coil is therefore

$$Z = \sqrt{R^2 + X^2} = \sqrt{10^2 + 31.4^2}$$
$$= \sqrt{1{,}087} = 32.95 \text{ ohms.}$$

Thus the current is $I = \frac{E}{Z} = \frac{100}{32.95} = 3.04$ amperes.

For a simple series circuit of this kind the power factor is $\frac{R}{Z} = \frac{10}{32.95} = 0.304$.

The power consumed is therefore

$$P = EI \times \text{power factor}$$
$$= 100 \times 3.04 \times 0.304$$
$$= 92.5 \text{ watts}$$

As there are no branches in the circuit and consequently only one value of current to deal with we can check this result by another method. This is done by calculating the power in terms of current and resistance, namely, $P = I^2R = 3.04^2 \times 10$

$= 92.5$ watts, as before.

Inductive Coil in Series with a Resistance.

Very frequently a circuit consists of an inductive coil possessing both resistance and inductance, connected in series with a non-inductive resistance. Knowing the voltage applied to the ends of the circuit, it is usually necessary to determine the voltage across the coil itself.

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Wireless Theory Simplified.—

A typical example is that of a choke connected in the anode circuit of a valve.

In a previous example we considered this arrangement, but on that occasion the coil itself was assumed to have negligible resistance. As a rule, however, in practice the coil resistance cannot be neglected in this way, and so our previous treatment of the circuit must be extended to meet the new conditions.

Consider a circuit such as that shown in Fig. 3 (*a*)

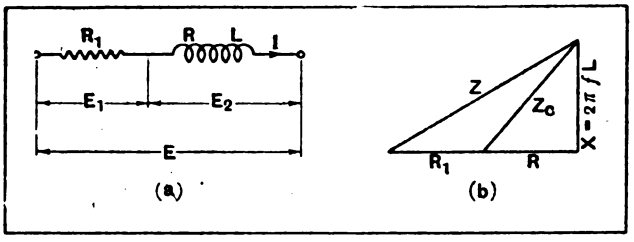

Fig. 3.—(a) Circuit consisting of a resistance R_1 in series with an inductive coil of resistance R and inductance L. (b) The impedances Z for the whole circuit and Z_c for the coil alone can be obtained from the impedance triangles.

where a non-inductive resistance R_1 is connected in series with a coil or choke whose resistance is R ohms and inductance L henrys. The total resistance of the circuit is $(R+R_1)$ ohms and its reactance $X=2\pi fL$ ohms where f is the frequency of the current in the circuit. Thus for the complete circuit the impedance will be $Z=\sqrt{(R+R_1)^2+X^2}$ ohms, whereas for the coil alone the impedance is $Z_c=\sqrt{R^2+X^2}$ ohms. If preferred, the numerical values of Z and Z_c can be found from the impedance triangles of Fig. 3 (*b*), in which case the diagram must be drawn to scale.

When a voltage E is applied to the ends of the circuit a current of $I=\frac{E}{Z}$ amperes will flow through it and the voltage across the coil itself will be $E_2=IZ_c$. Similarly the voltage across the resistance R_1 will be $E_1=IR_1$. From this it follows that the ratio of E_1 to E_2 is equal to the ratio of the external resistance R_1 to the coil impedance Z_c. *But the total applied voltage E is not equal to the arithmetical sum of E_1 and E_2* because these latter voltages are not in phase with each other—E_1 is in phase with the current as it is applied to a pure resistance, but E_2 leads the current by a considerable fraction of a cycle, as explained in Part VI. A numerical example will prove this.

Suppose that in the circuit of Fig. 3 (*a*) $R_1=5{,}000$ ohms, $R=1{,}000$ ohms and $L=10$ henrys, and that 100 volts (R.M.S. value) at a frequency of 50 cycles per second is applied to the ends of the circuit. Then the resistance of the complete circuit will be 6,000 ohms, and its reactance $X=2\pi\times 50\times 10=3{,}142$ ohms. The impedance $Z=\sqrt{6{,}000^2+3{,}142^2}=6{,}773$ ohms, and therefore the current will be $I=\frac{E}{Z}=\frac{100}{6773}=0.01476$ amp., or 14.76 milliamps.

The impedance of the coil itself is

$$Z_c=\sqrt{1{,}000^2+3{,}142^2}=3{,}295 \text{ ohms,}$$

and the voltage across it $E_2=IZ_c=0.01476\times 3{,}295=48.64$ volts. Similarly the voltage across R_1 will be $E_1=IR_1=0.01476\times 5{,}000=73.8$ volts.

It should be noted that although we have only 100 volts applied to the ends of the circuit there are 73.8 volts across the resistance R_1 and 48.64 volts across the coil. If we add these together arithmetically we get for their sum a value much greater than 100, namely, 122.4. This can be proved experimentally with a voltmeter. The reason is that E_1 and E_2 are out of step, and it is their *vector sum* which gives the total voltage across the ends of the circuit—the parallelogram method must be used, as explained in Part IV.

(*To be continued.*)

CLUB NEWS.

A Popular Visitor.

Captain Derek McCulloch, of the B.B.C., paid a surprise visit to the South Croydon and District Radio Society at their meeting on October 29th, bringing with him some special B.B.C. test gramophone records. The evening was devoted to comparative tests of various pick-ups which were connected in turn to the L.F. portion of the Club set.

The Society offers a warm welcome to new members.

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

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All About Valve Manufacture.

The recently formed Sheringham and District Wireless Society is already showing signs of a flourishing future, the meetings being largely attended. On October 30th Mr. Carter, of the Mullard Wireless Service Co., Ltd., lectured on "The Radio Valve: What it Does and How it is Made." With the aid of an excellent series of thirty lantern slides, members were able to obtain an insight into the intricacies of valve manufacture and operation. Applications for membership will be gladly received by the Hon. Secretary, Mr. C. R. Hunt, Church Street, Sheringham.

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Metal Rectifiers on the Film.

The new constructional film entitled "Metal Rectifiers," prepared by the Westinghouse Brake and Saxby Signal Co., Ltd., will be shown at a meeting of the Bec Radio Society on November 19th, at the Bec School, Beechcroft Road, Balham, S.W.17. This film, which was recently described in *The Wireless World*, demonstrates very clearly the operation of various circuits embodying metal rectifiers. Non-members are invited to attend the lecture, and those interested are asked to communicate without delay with the Hon. Secretary, Mr. A. L. Odell, 171, Tranmere Road, S.W.18. The lecture will begin at 7.30 p.m.

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Wireless in the Mediterranean.

"Wireless in the Mediterranean" was the title of an entertaining lecture given by Captain Leonard Plugge at the last meeting of the Wembley Wireless Society. The lecturer illustrated his talk with a number of photographs taken during his tour.

An attractive syllabus has been prepared covering the winter months, and this will be sent to enquirers on application to the Hon. Secretary, Mr. H. E. Comben, 24, Park Lane, Wembley.

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The Social Side.

That the Muswell Hill and District Radio Society are as interested in the lighter side as well as the technical aspects of radio was amply proved by the success that attended their Radio Dance and Whist Drive, held on November 2nd. Music was supplied by a gramophone pick-up working through a large power amplifier running off a 400-volt generator, an LS6A valve being used in the last stage, driving a moving-coil speaker. The whole of the apparatus was installed by members, and functioned excellently during the whole period of the dance—some four hours. On the termination of the whist drive most of the card-players participated in the dance, which lasted until Big Ben struck the hour of midnight.

Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road, London, N.10.

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Modernising Club Equipment.

The record of an excellent year's work was presented at the Annual General Meeting of the Tottenham Wireless Society on Wednesday, October 30th.

Mr. J. Burns reported that the Society's receiver had been modernised and equipped with an up-to-date eliminator, and that his Committee had undertaken to keep in repair the headphones used for the Prince of Wales Hospital. For the coming session Mr. O'Connor was elected Chairman and Mr. Bodemeaid was elected hon. secretary. It was announced that the Society's Cup and Shield for the most interesting lecture and demonstration given during the past year had been awarded to Mr. F. E. R. Neale.

New members will be welcomed at any meeting of the Society. These are held every Wednesday at 10, Bruce Grove, N.17. Hon. Secretary, Mr. Bodemeaid, 10, Bruce Grove, Tottenham, N.17.

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Broadcast Brevities

By Our Special Correspondent.

The Silent Twin.—Birmingham's Protest.—Centralisation.

The Second Transmitter.

"Hands off the poor man's station!" exclaims a contributor to the Savoy Hill post-bag, decrying attacks on the Brookmans Park transmitter. No thoughts of the second transmitter disturb his rest, nor need they, for he has still a full month in which he may twiddle his cat-whisker without fear of interruption. Despite rumours, I am officially informed that No. 2 transmitter has not yet begun radiating, although the B.B.C. was strongly tempted to use it for a public experiment on Friday, November 1st.

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A Near Thing.

The temptation came when complaints were made that the concluding broadcast of the Delius Festival would be limited to 5GB. The B.B.C. was anxious to please those who thirsted for Delius, but 2LO's mixed programme of military band, Sir Oliver Lodge, and vaudeville was already printed and published.

Came a brain wave. "Inaugurate the second station with a surprise transmission of Delius!" said someone. Savoy Hill actually gave the idea a thought, but that was all.

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B.B.C. as Pamphleteers.

The great pamphlet campaign is considered by Savoy Hill to be responsible for the relatively small number of complaints regarding the change-over from Oxford Street to Brookmans Park. Since the new station took over 28,000 pamphlets of advice have been distributed, in most cases with beneficial results. One old lady wrote saying that she and her maid, after studying the pamphlet, "got" Brookmans Park on a crystal set after two wireless experts had failed. A less fortunate correspondent in North Wales said: "Since you have moved to Langham Place I have been unable to pick up Toulouse"

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A Painful Transition.

But for the fact that the B.B.C.'s task, like that of the tight-rope walker, is always fraught with peculiar difficulties, one might be tempted to say that the Corporation had arrived at a difficult stage in its career. The difficulties are certainly aggravated at the present moment, however, by the onset of the slow and necessarily painful period of transition from the original scheme of programme distribution to the regional scheme.

As each locality is forced to yield up its individual niche in the ether, Savoy Hill undergoes a barrage of complaints from honest licensees to whom platitudes of "the greatest good for the greatest number" variety are like red rags to a bull.

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Birmingham is Roused.

The biggest outcry just now comes from Birmingham, which incidentally has suffered a definite loss in broadcasting prestige ever since the local station closed down in favour of 5GB. Birmingham was patient, however, until a few weeks ago, when the unkindest cut of all came in the form of the threatened disbandment of the Birmingham studio orchestra. It is true that many of the displaced musicians can be absorbed by the National Symphony Orchestra, but this is essentially a London combination, and Birmingham sees the transaction as another sacrifice on the altar of centralisation.

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The "D.-G." Goes North.

The seriousness of the situation can be gauged from the fact that Sir John Reith, Director-General of the B.B.C., attended a private conference at Birmingham last week to discuss matters with the Midland musicians. The meeting was held behind closed doors, and at the time of writing no disclosures have been made concerning future policy.

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Dangers of Centralisation.

The case of Birmingham has been, or will be, repeated throughout the country as the tendency to centralisation becomes more apparent. The local aspirations of Aberdeen, for example, are served by a station director, an engineer or two, and a typist, the programme coming through the tap from Glasgow or London. Newcastle has just reduced its local staff. Glasgow's large orchestra is being transformed into an octette for use on odd occasions.

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Provincial Interests at Stake.

Are the provinces justified in protesting? The majority of listeners will agree that they are, in the sense that if the provinces fail to look after their own interests, nobody else will. While the gradual change to the regional system is in progress the B.B.C. will be tempted on grounds of expediency to provide mass-production programmes; the danger to the provinces is that when the change is complete the B.B.C. will stick to the same methods. If the provinces are wise they will keep on clamouring.

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Ulster in Trouble.

Strangely enough, while the cry in Great Britain is against centralisation Northern Ireland is pleading for a little more. In the past fortnight Savoy Hill has received some bitter complaints from Belfast to the effect that the Ulster listener is left out in the cold.

It is alleged that 2BE works on a useless wavelength (242.3 metres); that half its radiation is wasted on the Irish Sea; and that the alternative programme from 5XX (when it *is* alternative) is unsuitable for Irish listeners.

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B.B.C.'s Reply.

In reply, the B.B.C. regrets that a change of wavelength is impossible at the present moment owing to the international situation, and points out that 5XX gives a reasonably good service to Northern Ireland. Until Ulster's high-power station is erected in two or three years' time it looks as if listeners will have to make the best of a bad job.

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"Effects" by Gramophone.

Sound effects will contribute prominently to the realism in a programme entitled "Intimate Snapshots," to be broadcast on November 22 from 5GB.

Lance Sieveking, the author, takes as the central idea the theory that for many people life is a series of dull and often meaningless repetitions. His examples prove it and afterwards show the contrary.

The atmosphere of a tube station and newspaper office will be reproduced by means of gramophone records prepared on the spot.

FUTURE FEATURES.

London and Daventry.

NOVEMBER 18TH.—A National Lecture—Prof. G. M. Trevelyan: "The Historical Aspect of the Union of England and Scotland, 1707."

NOVEMBER 20TH.—"Typhoon," a play by Conrad.

Daventry Exp. (5GB).

NOVEMBER 19TH.—Students' Songs.

Cardiff.

NOVEMBER 20TH.—Concert by Victors at National Eisteddfod of Wales, Liverpool, 1929.

Manchester.

NOVEMBER 18TH.—Gilbert and Sullivan Programme.

Glasgow.

NOVEMBER 21ST.—Speeches by the Duke of Montrose and H.R.H. the Prince of Wales at Meeting of Scottish Branch of Royal National Lifeboat Institution, S.B. from Edinburgh.

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THE WIRELESS SCHNEIDER TROPHY

By D'Orsay Bell M.A.

In Quest of the Short-wave Record.

IT is high time that radio learned the uses of publicity. How many people know anything about that most exciting international contest which has been going on now for several years—the struggle to break the short-wave record—or, if you prefer it, the race for the highest radio frequency? How many? I repeat. The answer is in the interrogative, and would remain so but for the fortunate chance that *The Wireless World* has commissioned me to look into the matter.

The race, under the present rules, did not begin till some years after the revolution in wireless caused by the introduction of the three-electrode valve. Before this, a few desultory flights had been made, with prehistoric machines of the spark type, producing heavily damped waves with little power behind them. Then came the valve—but also the War: people were preoccupied, the early valves had high inter-electrode capacities, and the pursuit of the ultra-shorts was shelved for a time. But nothing is safe for long from the restless researcher. By ingenious wangling of the circuits someone induced an ordinary valve to give a wavelength far, far shorter than any it had dreamed of giving. That started it: at once, all over the world, earnest workers went one better; no sooner had an American proudly announced the production of a three-metre wave than an Englishman replied by generating a two-metre one; a little later a German would write reams to describe his researches leading to the production of a one-metre wave, and before the ink was dry a Japanese would brandish a 90-centimetre wave. . . . And so began the race for the Wireless Schneider Trophy — so-called from the German word *schneider*, a cutter, because the idea is to cut off another centimetre or two.

"Nothing is safe for long from the restless researcher."

In spite of lack of publicity, marvellous progress has been made, especially in the last year or so. As a general rule, the valves used are more of the receiving than the transmitting type, so that the power behind the waves is not very great—often only one or two watts; but the waves are genuine, undamped waves, real "C.W." suitable for telephony and other modern usages; and the smallness of the power is largely compensated for by the efficiency of radiation. A recent record—I dare not say "the present record," because by now someone has probably stood a valve on its head and got a millimetre or two shorter—is 3.5 centimetres. This, I think, goes to Poland (Potapenko up). It is rather a remarkable thought that we now have a complete range of wireless waves, from the giants—measured in miles—used in long-distance commercial work down to this midget of about 1½in., all produced by the ubiquitous valve. Now just as you find stick-in-the-muds pompously demanding what is the good of these six-mile-a-minute aeroplanes and these four-mile-a minute motor cars, "for all practical purposes, hrrmph?" so you find them condemning the time and trouble spent on these ultra-shorts as being wasted on matters of "purely academic interest." It is worth while looking to see if they are any nearer the mark now than they were about the aeroplanes and motors.

I have already indicated[1] the extraordinary possibilities of waves of about 1 to 5 metres from a medical point of view, so I will not repeat myself. These same wavelengths seem very promising for communication of a certain kind—primarily, perhaps, for military purposes. With an input to the aerial of a tenth of a watt, signals have been obtained at loud speaker strength from an aeroplane twenty-two miles away; with one watt, telegraphy is possible from an aeroplane about eighty miles away. These ranges are nothing much compared with those obtained with ordinary "short" waves (400 miles with 2 watts to the aerial on a 50-metre wave, for instance), but the

[1] *The Wireless World*, 7th August, p. 134.

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The Wireless Schneider Trophy.—

" ultras " have particular properties of their own which are likely to add to their value enormously. In the first place, they give complete freedom from atmospherics and from fading (since the Heaviside layer is not mixed up in their propagation), and—and this is where the German workers get excited—their range can quite definitely be limited. Travelling, like light, in straight lines, a ray of ultras reaches the horizon (as seen from its transmitting aerial) and passes on into oblivion in space, not clinging to the ground nor being reflected back to earth by an officious Heaviside layer. Signals from a 1-watt transmitter may be quite strong at the horizon, but a little farther on they will almost have vanished—and even the use of fifty watts instead of the one will make them carry hardly any farther.

You see the possibilities of such waves for military purposes—where interception (with subsequent decoding) is such a bugbear? Can you not picture the indignant enemy, with a loop aerial at the end of a stick, vainly trying to stretch high enough to capture the waves passing derisively over his head into the void? And the small size of the waves, too, makes them dirigible by quite reasonably small reflectors, so that they can be concentrated into a beam and sent in the required direction only. This becomes still easier as the wave gets shorter and shorter, and both Germans and French have had excellent results with waves of 20 to 40 centimetres, concentrated at the transmitter and collected at the receiver by parabolic metal mirrors. The Germans, in fact, have succeeded in telephoning on waves as short as 14 cms.—only over a mile or so, at present, but with ridiculously simple apparatus; and as the same special valve is used as transmitter and receiver this simple apparatus gives two-way telephony.

So you see these ultra-short waves are by no means just " highbrow " stunts. On the contrary, they are full of practical possibilities. At present they are in their infancy, and puny; but already the Americans are generating 4-metre waves with nearly a kilowatt behind them, using a big water-cooled valve; and no doubt very soon even the " centimetre " waves will have plenty of power. And nobody quite knows what will happen when we get " millimetre " waves—or less—with plenty of power behind them. Already Arkadiewa has produced waves less than a tenth of a millimetre long; that is to say, he has crossed well over the boundary line and invaded the country of the infra-red heat radiation. The Schneider Trophy does not go to him—his waves do not comply with the rules; they are not true " C.W.," but rather of the " whip-crack " type, produced by a weird and special form of spark; unsuitable for telephony and with very little power behind them. All the same, they are real waves; they can be concentrated by quartz lenses and reflected by concave metal mirrors only 6in. across. . . .

The water-diviner looking worried.

Radiant Heat by Radio ?

The whole subject teems with interesting undiscovered possibilities in all kinds of strange directions. Listen to this, for instance: a German researcher named Heinrich, playing about with short and ultra-short waves, glanced out of his window and saw a little crowd in the field outside, near his transmitting aerial. He soon saw that the crowd was watching a water-diviner, who was giving a demonstration of his art; he was also, Heinrich noticed, looking worried. But as Heinrich watched, the worried look vanished, and he went on quite happily with his demonstration; and Heinrich returned to his work. But as he again pressed the key, a sudden thought struck him, and he kept the key pressed and looked out of the window again. Sure enough, the diviner was looking worried again—more so than ever, for by this time he was nearer Heinrich's aerial. For it turned out, quite definitely, that whenever Heinrich pressed his key the water-diviner's hazel twig became seriously upset. So I will leave you now to face the very latest problems: (1) Can we transmit radiant heat from our wireless aerial? and (2) Is water-divining only another branch of radio?

TRADE NOTES.

The Six-Sixty Radio Co., Ltd., 122, Charing Cross Road, London, W.C.2, announce that they have moved to larger premises at " Six-Sixty House," 17-18, Rathbone Place, Oxford Street, London, W.1. The telephone numbers are Museum 6116-7.

o o o o

Owing to expansion of business, the Lisenin Wireless Company, Connaught House, 1a, Edgware Road, Hyde Park, London, W.2, have acquired more commodious premises at 5, Central Buildings, High Street, Slough, Bucks. The telephone number is Slough 652.

o o o o

The Hendon Lamp and Accessories Co., Ltd., 104, Southampton Row, London, W.C.1, would be pleased to receive from radio manufacturers, particularly those making portable sets and battery eliminators, detailed particulars of their products.

o o o o

The General Electric Co., Ltd., " Magnet House," Kingsway, London, W.C.2, have recently opened a branch office at 3, Campbell Street, Leicester. Mr. W. J. Hodgkins, of the Birmingham branch, has been appointed manager. The telephone number is Central 58776, and the telegraphic address " Electricity."

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PENTODE POSSIBILITIES

Using the Pentode in Reflex Receivers.

EXCEPT for a few casual references, the writer has seen no mention of the fact that the pentode valve can well be used for purposes other than that for which it was originally designed. As a high-frequency amplifier, for example, the pentode will give, with the usual neutralised circuit arrangement, greater magnification than can be attained by any triode available. The heavy anode current drawn by the pentode renders its use for this purpose alone very uneconomical, but its ability both to amplify efficiently at high frequency and to handle power enough for working a loud speaker renders it the ideal valve for dual amplification in a simple reflex set. Those who have attempted to design a satisfactory reflex receiver will realise that in the pentode there is available, for the first time, a valve that can really " pull its weight " as dual amplifier.

Figure 1 shows a reflex circuit, employing a crystal detector, which has proved highly satisfactory in use. On the high-frequency side it is a quite conventional neutrodyne, except that the secondary of the high-frequency

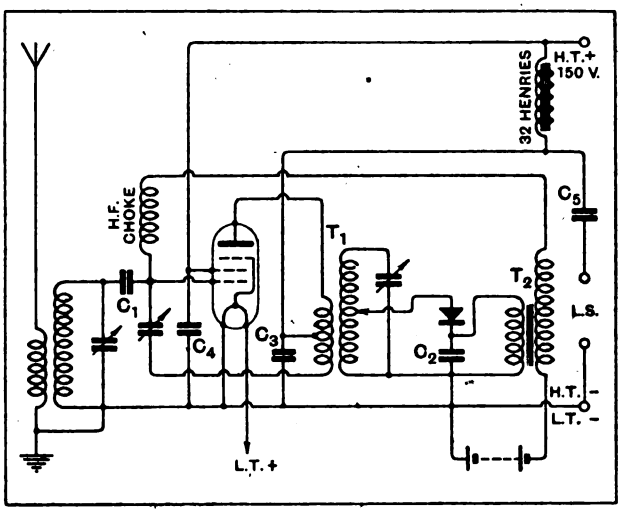

Fig. 1.—A one-valve pentode reflex circuit giving powerful loud speaker signals. The values of components are as follow: C_1, 0.0001 mfd.; C_2, 0.0003 mfd., need not be incorporated if already present in the transformer T_2; C_3, 0.001 mfd.; C_4 and C_5, 2 mfds. each; T_1, secondary 65 turns of 22 D.S.C. on 3in. former. Tapped 5, 10 and 20 turns from earth end. Primary and neutralising coil, each 28 turns of 40 D.S.C. overwound on ebonite spacers; T_2, high-ratio L.F. transformer.

transformer T_1 is tapped in order that the requisite step-down to the crystal may be obtained. The transformer T_2 may have a high ratio without detriment to quality, as the impedance of the crystal is quite low. Messrs. Ferranti were good enough to make up for the writer an experimental model of their AF5 transformer with a 15:1 ratio and a 10 henry primary, and this has proved very satisfactory for the purpose. It is probable that they would supply this to order to anyone desirous of experimenting along the same lines.

From the secondary of T_2 the rectified signals are fed, through a radio choke, to the grid of the valve, the condenser C_1 serving to prevent a short-circuit of the low-frequency signals. Grid bias is provided through the transformer secondary and the radio-choke. Every crystal tried has been found satisfactory with the single exception of carborundum, which will not rectify efficiently the high voltages with which it has to deal in this set.

Overloading Troubles.

In common with all other reflex circuits, that of Figure 1 strongly resents overloading, which results, not in the mild distortion usual in " straight " sets, but in intermittent oscillation at low frequency lasting as long as the overloading persists. As soon as even the smallest degree of overloading is permitted, the loud speaker appears to reproduce all loud notes as toneless but most offensive grunts. It is absolutely essential, therefore, to limit the output from the valve to that which it can handle without any trace of the slight overloading that is usually permissible.

When a moving-coil speaker, which has a fairly low impedance to all audible frequencies, is in use, the pentode will accept far louder signals without overloading than when a speaker of moving armature type is chosen, for these offer a very high impedance to the upper range of speech frequencies. This alone would indicate that greater signal strength should be available before the " reflex grunt " makes its appearance if a moving-coil speaker is used, but there is still to be taken into account the enormously greater sensitivity of the moving-coil as compared with the moving iron. These two points together amply account for the observed fact that the reflex receiver shown produces a cheerful roar of first-class quality from any station within its range, provided that a moving-coil speaker is used, while with any other type of speaker signals have to be kept down to a miserable tinkle if good quality is to be maintained.

Eliminator for D.C. Mains.

A further development of the circuit is possible for those who are in possession of D.C. mains. With the aid of the eliminator shown in Figure 2 it is quite possible to dispense with both filament and anode batteries, lighting the filament of the valve *gratis* by putting it in series with the magnet of the moving-coil speaker. This must, of course, be chosen to pass, as a minimum, the current required by the pentode, and it is almost essential to employ, if only in setting up the eliminator, either a milliammeter at A or a voltmeter at V in conjunction with a variable resistance to ensure that the filament is

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Pentode Possibilities.—

correctly run. If the field magnet passes considerably more current than the filament requires, a 50-ohm rheostat may be used in the position R_1 to shunt away the excess from the filament, but if magnet and filament

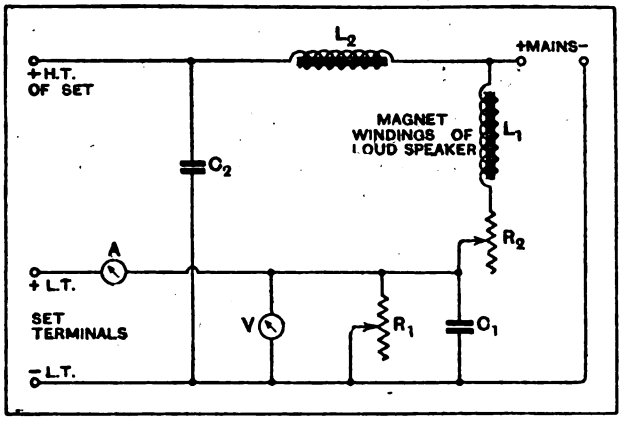

Fig. 2.—Complete eliminator for use on D.C. mains with the receiver of Fig. 1. A number of the components may be omitted except with the "roughest" of mains.

require about the same current, a series resistance at R_2 will be more suitable. Except perhaps for preliminary experiments, R_1 and R_2 will not both be required. If hum is experienced, an electrolytic condenser of 100 mfd. capacity or over may be tried at C_1, but it is not likely to be needed.

The H.T. supply circuit is simplicity itself, and need consist of no more than the single choke and condenser shown, together with any resistance that may be required to reduce the voltage at the anode of the valve to the maximum permitted by the makers. In many cases it will be found that the resistance and condenser will be sufficient, without the choke, to provide the very slight smoothing required. Owing to the crystal rectifier, hum is not likely to be troublesome, except when using very "rough" mains. The total consumption, including the speaker field, is about one-thirtieth of a unit per hour. As with every receiver driven by D.C. mains, safety condensers in both aerial and earth leads are absolutely necessary, though they are now shown in the diagrams.

In the form shown in Figure 1 the receiver is not difficult to set up and get into working order, especially as the screening required is not extensive. It has, however, the drawback that it will only receive the local station and 5GB with any certainty. Those who are fond of experimenting may like to try replacing the crystal with a valve detector using reaction. They are warned, however, that though there is no reason why such a combination should not, eventually, be persuaded to work satisfactorily, it may well prove too unruly for all but the most experienced and the most persevering.

A. L. M. S.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

THE REGIONAL SCHEME.

Sir,—With regard to the "regional scheme" it seems that the B.B.C. can only do one of two things :—

(1) Restrict their energies so that the listeners near their main stations are satisfied.

(2) Continue their forward policy to the ultimate benefit of the majority.

In my opinion the first would be contrary to all laws of progress, while the second is the one which has put this country into such an enviable position as it now holds in the radio world. It is no use putting the brake on progress.

Eastwood, Notts. L. W. GROVER.

Sir,—I disagree most strongly with your correspondent, Mr. Hobday, with regard to Continental programmes.

The sole reason why I invested in a screened-grid "three" was my inability to hear anything (worth wearing phones for) from the local station in the evenings, which is the only part of the day available for the average man. Week after week passes, and there is nothing but fifth-rate variety and jazz bands after 8 o'clock, a talk only of interest to a few people, or a scientific discourse so elementary as to be suitable for a kindergarten school.

How anyone can scan the programmes published by the B.B.C. in *World Radio* from such stations as Leipzig, Hilversum, Hamburg, Munich, Cologne, Turin, Toulouse, or Kalundborg, and say they are inferior to those printed in the *Radio Times*, passes my comprehension. Not only does the average orchestral concert contain better music, but it is better performed. Most of the great composers came from the "Continent," and the musicians of the Continent are best able to interpret their works.

Even the dance music from Germany or Denmark is played by ordinary orchestras, and is pleasant to listen to after the raucous blare, whine, and thump from 2LO, etc., etc.

If the Regional, or any other scheme, prevents me listening to foreign programmes, I shall turn my aerial into a saucepan-scourer and light my pipe with my licence. J. E. ROBERTS.

Streatham Hill, S.W.2.

Sir,—The correspondence you publish on the above subject prompts me to express another point of view.

I submit that (*a*) the regional scheme was never wanted, and (*b*) it is already out of date.

In regard to (*a*), if there had been any real demand for alternative programmes, the ridiculous system of sending out the same programme from 2LO *and* all the relay stations *and* 5XX, *and* to a large extent all the provincial main stations as well, would not have been allowed to continue, when 5XX could have been providing an alternative for the vast majority of listeners to all the other stations.

With regard to (*b*), it is obvious to the meanest intelligence that the ether is grossly overcrowded, and that sooner or later (and the sooner the better) there will have to be a drastic reduction in the number of wavelengths and stations in use in Europe. When that happens, since the only logical method of distributing wavelengths is more or less according to the *area* of the various countries (for the more sparse and scattered the population is the more necessary is an efficient broadcasting service—it is a mere luxury for town dwellers, by comparison), this country will have to put up with three or four exclusive wavelengths, and then the B.B.C.'s twin transmitters will be useless.

In the present state of affairs really high quality reproduction is unattainable, since even if the 9-kilocycle heterodyne note of the adjacent broadcasting stations are suppressed, one still gets interference from the side bands of these stations. It might, in fact, improve matters a little if no broadcasting were allowed to transmit any side bands above 8,000 cycles.

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They would be no loss, since they cannot be received, and at least they would not encroach on the fundamental band of the next station. A. K. GORDON.

Crowborough, Sussex.

EMPIRE BROADCASTING.

Sir,—I have read with much interest the correspondence in your columns on the subject of Empire broadcasting, and the letter in your issue of September 11th, signed "Radiox," strikes me as very much to the point. As a Britisher, I appreciate the London programme more than any other, and I have formed a habit of rising at 2.30 a.m. to pick it up. Sometimes I find it repays the effort of early rising, but by no means always. It would, therefore, be most helpful to those situated 7 hours east of Greenwich if 5SW were to give at midnight a brief summary of the next evening's programme, and enable us to decide between sleep or listening.

I agree with "Radiox" that news items are badly wanted. The fifteen minutes' interval that takes the place of the news bulletin sends me back to bed disgusted on five nights each week. If the news bulletin does not affect the sales of newspapers at home, why should it affect the cable service?

Bankok, Siam. TYRO.

Sir,—I had been holding my hand to see what the opinions of other readers might be at the reopening of the 5SW question before expressing any ideas of my own. However, the rest maintaining silence for the moment, I feel I must make some comment on your editorial of October 23rd.

On a recent voyage to and from Australia I took some trouble to get information about the reception of 5SW and to make full notes on the reception of short-wave stations during the return voyage. The pivot of debate evidently no longer is whether or not there should be an Empire station, but rather whether there can be. You have suggested that any difficulty 5SW may have had in carrying out its responsible duties of broadcasting to the Empire is partly the fault of the engineers in charge of the station, and a correspondent suggests a wavelength change. (In passing I do not see how a listener in the Mediterranean, who is so very close to the splendid European medium-band transmissions, can demand a short-wave programme at all, or possibly criticise wavelength policy by results. Surely we can agree that 5SW need not consider listeners this side of Port Said or the Canaries.)

The case to be made is that there are considerable parts of the Empire in which reception having a good entertainment value is possible. I hope we shall hear what the listeners in remote parts have to say; I am prepared to open the discussion by denying the possibility in all but a very few parts of the world of regular reception of short-wave stations that would satisfy non-technical listeners.

To go on throwing Eindhoven at the B.B.C. is *vieux jeu*. During September, 1929, Eindhoven seemed only to be working once a week. If correspondents want a new brick, it is the Berlin station Königswusterhausen, broadcasting only a very few kilocycles from the Eindhoven frequency and seeming to have more power, better quality, and a better radiation system than the Philips station.

Within 5SW's first skip distance (this seems to be between 1,000 and 1,500 miles) the German station certainly was a revelation of what is possible near 32 metres; but we have agreed to discount short range reception. Between 2,000 and 5,000 miles, which of the two suffered the less from the high-speed fading that spoils reception was quite casual. At greater distances, most of my observations seem to be in favour of 5SW.

On most nights the log would run after this style for long-distance reception :—

Tuesday, September 17th, 1929. 27° S. : 12° E.

5SW.—Signal strength good at 8 p.m. (local time), but high speed fading violent. Signal strength increased though a little long period fading till about 11 p.m., when it was R7. Hardly worth listening to in spite of good strength.

KDKA.—10.20 weak, but readable and steady. Fading only slight.

Königswusterhausen.—8.30-10, high speed fading. R2.

The qualifying clause "in all but a very few parts of the world" was meant to apply to the reception of 5SW in the Far East along the China Coast. I am told that in those parts 5SW comes in before breakfast as satisfactorily as a local station. But do you want dance bands before breakfast?

Hampstead, N.W.3. M. A. SPENDER.

Sir,—On March 17th last I wrote to you *re* the information I had received from the B.B.C. on the subject of the suppression of the news bulletins. They explained that the news was not broadcast because 5SW was an experimental station only. I pointed out that 5GB is also an experimental station, yet the news is broadcast from it regularly. This letter you published.

In the number of *World Radio* for August 2nd, on page 156, in the centre column, occurs the following statement: "We receive frequent enquiries as to why the news bulletin is not transmitted from 5SW. All that can be said in this connection is that it is necessary to omit this item from 5SW transmissions for reasons which are at present beyond the control of the B.B.C."

Obviously the explanation given in their letter to me dated February 22nd could not be considered satisfactory, and it is therefore not surprising that they should now have published something very different by way of explanation.

It is not pleasant to think that any such body as the B.B.C. could even be guilty of want of good faith. Yet the facts as stated above can only tend to increase the suspicion and dissatisfaction felt by most overseas listeners in regard to everything connected with 5SW since it came into being.

Moreover, the explanation published in *World Radio* raises another point. The only control over the B.B.C. which is generally supposed to exist is that of the Government through the Postmaster-General. A question in the House ought to clear up the point of the objection of the Government to allowing the Colonies and Dominions to hear the Home news, and, if they have such an objection, on what grounds?

60° WEST.

B.B.C. TRANSMISSIONS.

Sir,—Surely it is time that criticisms as put forward by Mr. McCormack in your issue of October 23rd were brought to an end. As Mr. McCormack makes no reference, direct or indirect, to the removal of all sources of error in his set, he implies that all frequency distortion or attenuation occurs in the B.B.C. land lines and/or transmitters.

If your correspondent is capable of

(*a*) The complete elimination of side-band cutting in his own receiver whilst avoiding radio interference,

(*b*) Accurately distinguishing between side-band cutting in his receiver and attenuation of the higher frequencies in the land lines,

he is well on the way to a perfect set, and many readers would like to know how (*a*) is achieved.

If and when this perfect set be proved to exist, so much will then depend on the method of reproduction that for the moment further comment is superfluous. Suffice it to point out that further definite proof of the perfect reproducer will be required before such criticisms are fair. As you, Sir, are aware, the human ear is so adaptable to varying conditions as to be quite unreliable as evidence of perfection, and gives but evidence of the personal preference of its owner.

Until such time as this perfection be proved to exist, surely it is better to make the best use of existing radiations. The B.B.C. will admit that their radiations are not perfect, but would also probably claim that they were at least as good as any set reproducing them. If proof, and not judgment by ear, were furnished of really serious defects in transmission, the Chief Engineer would doubtless take steps to rectify his errors.

As a minor point: we cannot all live in the "A" service area of Brookmans Park, and therefore we cannot all have the Queen's Hall concerts as "first class," direct or "local." We must therefore accept the next best thing. But why complain in the same letter of the "third rate" or "fifth rate" land line transmissions radiated from 5NO when admitting there are available the "second rate" transmissions of 5XX?

Yorkshire. FAIR PLAY.

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READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Valve Life.

It seems to be quite common practice nowadays to heat the filament of an output valve with raw A.C. at the correct voltage; I am told that the life of valves supplied in this manner is considerably less than when a battery is used. Can you confirm the accuracy of this statement, and also tell me if the falling-off, should it exist, is in any way serious?

S. C. J.

It is regretted that we have no definite data on this matter, but it is to be assumed that the life of a valve fed with raw A.C. is somewhat shorter than with the alternative battery supply. We do not think that this effect is at all serious; indeed, any reduction in valve life is probably altogether insignificant.

○○○○

A Push-button Regional Receiver.

I am thinking of using up some spare parts for constructing a simple domestic set for reception of the alternative programmes from Brookmans Park (when they begin).

My two-H.F. set will be used on the outside aerial for distance reception, and it is proposed that the other receiver shall be connected and fed from an inside aerial. In order to have an ample margin of safety, it is proposed to use a single H.F. stage, from which no special attempt will be made to obtain maximum amplification. Will you please show me how a switching scheme for this stage may be arranged, in order that it will be possible to use pairs of semi-variable condensers tuned to the wavelength of the two transmissions? It seems that, after having once tuned the set, it should be possible to arrange matters so that either transmission can be received by manipulation of change-over switches, without any other external control beyond, of course, that for the filament circuit.

T. F. S.

It should not be difficult to arrange a set on the lines you specify, particularly as no very great efficiency will be required at your distance from the regional transmitters. We suggest the arrangement shown in Fig. 1, in which C_1, C_2, and C_3, C_4 are, respectively, the condensers for tuning aerial-grid and H.F. transformer secondary circuits to the alternative wavelengths. These are thrown in circuit by means of the switches S_1, S_2; with a little care, these may be linked together mechanically and operated by a single knob.

As an additional refinement, it would be possible to arrange matters so that the filament circuit is "off" when the switch is in the central position.

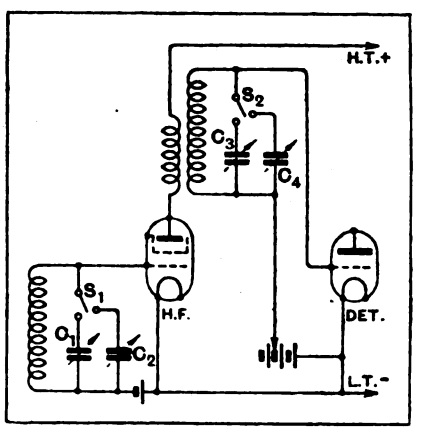

Fig. 1.—For reception of twin Regional transmissions: simple change-over switching.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

In our diagram we have shown an anode bend detector, but the scheme would be applicable to a set in which grid detection is used, although any attempt to include reaction would tend to complicate matters.

○○○○

Omitting Decoupling Resistances.

I have a Ferranti eliminator, which, as you will know, includes anode feed resistances for the various circuits; in these circumstances, would it be quite in order to omit the present decoupling resistances in the "1930 Everyman Four"? H. J. S.

In order to prevent the undesirable circulation of H.F. currents, we suggest that R_8 and R_9 should be retained. Otherwise your proposal is not open to criticism, although if you are attempting to obtain the very fullest magnification of which the receiver is capable, it might be desirable to leave a resistance of, at any rate, a few hundred ohms in the position at present occupied by R_{10} (in the detector anode circuit).

○○○○

An All-wave Frame Aerial.

Have you ever described the construction of a frame aerial for both medium and long broadcasting wavebands? If so, will you please refer me to the back number in which the description appeared? W. J. M.

Full details for constructing an all-wave frame aerial were given in *The Wireless World* for July 27th, 1927.

○○○○

Mounting an S.G. Valve.

Do you consider it better to mount a screen-grid high-frequency valve in a position where it is unaffected by the field surrounding the coils, or to arrange it in such a way that the grid and plate sections of the valve are in the corresponding screening compartments of the set? B. P. A.

Where but one H.F. stage is used, this is not a matter of any great importance, even when one is aiming at an exceptionally high magnification; but in the design of receivers with two or more H.F. stages it is usual practice to screen the valves from the apparatus associated with the tuned circuits.

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Record III Modifications.

Would it be possible to use a P.625 valve in the output position of the Record III? I already have a valve of this type, and a power transformer with outputs of 4 volts, 6 volts, and 250 volts; the latter is for H.T. supply, of course, and the winding has a centre tapping.

If it is possible to use these components, will you please give me a circuit diagram of the modified filament and heater circuits?

F. McC.

There should be no difficulty in arranging matters so that your valve and transformer can be used. In Fig. 2 we give a suitable circuit arrangement; it will be noticed that a potentiometer and by-pass condensers are shunted across the low-tension output winding, which feeds the indirectly heated H.F. and detector valves.

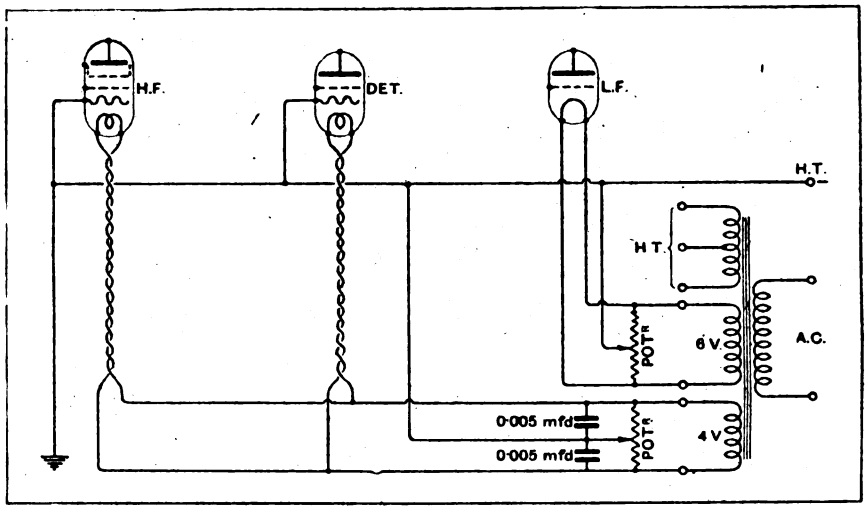

Fig. 2.—A satisfactory modification of the Record III, allowing the use of a directly heated valve in the output position.

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An Unstable Portable.

I am sending you the circuit diagram of my recently constructed four-valve portable, which is giving a good deal of trouble through lack of stability. Can you suggest a likely source of the trouble, or recommend any additions that can be made? J. R. B.

From the information you give about your set, it is extremely difficult to help you. One naturally expects to encounter a good deal of trouble in obtaining complete stability in a portable receiver unless a well-tried design is followed, as it is inevitable that there will be a good many stray couplings; these must be found and removed, or, at any rate, their "sense" must be altered so as to produce an anti-reaction rather than a reaction effect.

It is noted that your set includes complete decoupling of the various H.F. circuits, and apparently thorough screening where necessary. Of course, we cannot say if the joints of the screening box are sufficiently well made, and we would advise you in the first place to look to this point.

A common source of trouble in portable sets is interaction between the loud speaker leads and the built-in frame aerial; in spite of fairly elaborate "H.F. stopping" preeautions, a modicum of H.F. energy is often found in the former circuit.

We advise you to try the effect of connecting a by-pass condenser—of, say, 0.002 mfd.—between plate and anode of the output valve, and also to connect an H.F. choke between the plate of this valve and the loud speaker.

The Output Anode Circuit.

It is noticed that, although the majority of modern sets seem to have decoupling resistances and condensers in the anode circuits of H.F., L.F., and detector valves, no particular precautions seem to be observed in the case of the output valve. Would it not be an advantage to apply this method of preventing interaction in this case as well, particularly in view of the fact that the energy in this circuit is much greater than in any other, and presumably more likely to lead to trouble? C. M.

We would point out in the first place that it is seldom practicable to add a resistance capacity filter in an output anode circuit, because the current is generally so great that a resistance of the value necessary for adequate decoupling would bring about an excessive drop in voltage. In any case, it must be remembered that the decoupling arrangements customarily recommended nowadays are "two-way" devices; not only do they deflect H.F. or L.F. energy from a common source of anode current supply, but they also prevent the feed-back of energy from the output circuit to the anode circuits of which they form a part, and, what is more important, they consequently prevent the passing back of energy to the grid circuits.

It may be added that the anode circuit of the last valve is almost completely decoupled when a choke filter arrangement is used. The same holds good with a push-pull arrangement.

o o o o

Long Waves for Long Range.

My advice has been asked regarding the choice of a four-valve set for use in Scotland in a district where I know from experience that Daventry 5XX transmissions provide the most consistently good signals.

It is observed that comparatively few commercial sets are designed for as good a performance on the long waves as on the medium band—I suppose because this is unnecessary in most districts. Can you refer me to any set likely to have a performance above the average as far as long-wave amplification is concerned, and which at the same time is easy to operate? D. B. L.

Reception of long-wave signals is generally determined by the ratio of signal strength to atmospherics, and in any case it is, in a modern receiver, quite easy to get as much sensitivity as can ordinarily be usefully employed, although there are sometimes occasions where one can make use of a high degree of magnification. We suggest that you should consider the Pye Type 460 receiver, as this set includes long-wave circuits of unusually high efficiency.

FOREIGN BROADCAST GUIDE.

LAHTI

(Finland).

Approximate geographical position: 60° 25′ 38″ N. 28° 10′ 00″ E.

Approximate air line from London; 1,130 miles.

Wavelength: 1796 m. Frequency: 167 kc. Power: 40 kw.

Time · Eastern European (2 hours in advance of G.M.T.).

Relays programmes from Helsingfors (221 m.; 1355 kc.; 0.9 kw.).

Standard Daily Transmissions.

G.M.T. 05.15 morning health exercises; 07.00 and 11.00 sacred service (Sundays only); 12.30 concert (Sundays only); 17.30 or 18.00 opera or concert (daily); 19.45 news in Finnish and Swedish. Occasionally on Saturdays at 21.00 dance music.

Usually closes down at 21.00.

Lady announcer. Call (in Finnish): *Huomio! Huomio! taala Suomen yleisradio Helsinki-Lahti.* When Swedish transmissions are given: *Giv akt! Har Finlandsrundradio Helsingfors-Lahti.*

Time signal (at 17.00 G.M.T.): 1 stroke on a deep-toned bell.

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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GUIDE TO RECEIVERS.

IN this issue we publish our fourth annual Buyers' Guide to Receiving Sets of To-day. This annual feature is not only becoming of the utmost value to would-be purchasers of complete sets, but it has the additional advantage that the publication of this information puts our readers *au fait* with the present tendency in design and indicates very clearly the types of receivers on which manufacturers are concentrating.

It is noticeable from the figures which this year's Buyers' Guide to Sets provides that the popularity of mains-operated receivers is increasing, whilst another point of interest is that the popularity of portable sets amongst manufacturers has about reached its zenith. By this we do not mean that the portable set is by any means a thing of the past, but that manufacturers, rather than develop new portables on the lines of those previously marketed, are designing sets which are self-contained except in so far as they require to be connected to the electric supply mains for operation. The new receiver has the advantage over permanently installed sets that it can be moved from one room to another, and is independent of an aerial.'

The sets of to-day serve once more to emphasise the fact that receivers are designed to suit the valves which the valve manufacturers develop, and it would appear that at present, at any rate, it is the valve manufacturers and not the manufacturers of sets who set the pace and control the evolution of the wireless receiver.

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TELEVISION: A STATEMENT OVERDUE.

THE wireless picture transmissions which the B.B.C. have been conducting over an agreed period of twelve months have now come to an end and, according to our information, the B.B.C. has decided not to continue them because, in their opinion, there is not sufficient evidence of public interest.

Whilst it may be difficult to find a good reason for quarrelling with this point of view, yet we feel strongly that a blunder has been permitted somewhere because to us it seems unfair that a section of the public, however small, should have been induced to invest in the purchase of picture-receiving apparatus only to find, after a comparatively short run, the transmissions which could be picked up in this country on the instrument discontinued. We should, of course, be told that all purchasers of the apparatus were advised that the transmissions conducted by the B.B.C. were only experimental and their continuance could not be guaranteed, but how many people, we wonder, would have been prepared for such a decision as has now been made.

In the broadcasting of television experiments by the B.B.C. such as is now proceeding, we have another instance of questionable policy, but we feel that we should exonerate the B.B.C. from responsibility for both these enterprises, because if our information is correct, they were thrust upon them by the Post Office, because the Post Office was not prepared to grant independent experimental facilities to those concerns which were commercially interested in picture transmission and in television. How long, we wonder, will the B.B.C. television broadcasts continue? Is it not time that we had from some authority a general report and a statement of the number of persons who "look in" to these transmissions? The Television Society, which was formed some time back with the object of furthering the development of the technical side of the subject, might, we think, quite reasonably be regarded as a suitable body to form a committee to investigate the matter, provided this committee was chosen from amongst unbiased and unprejudiced persons.

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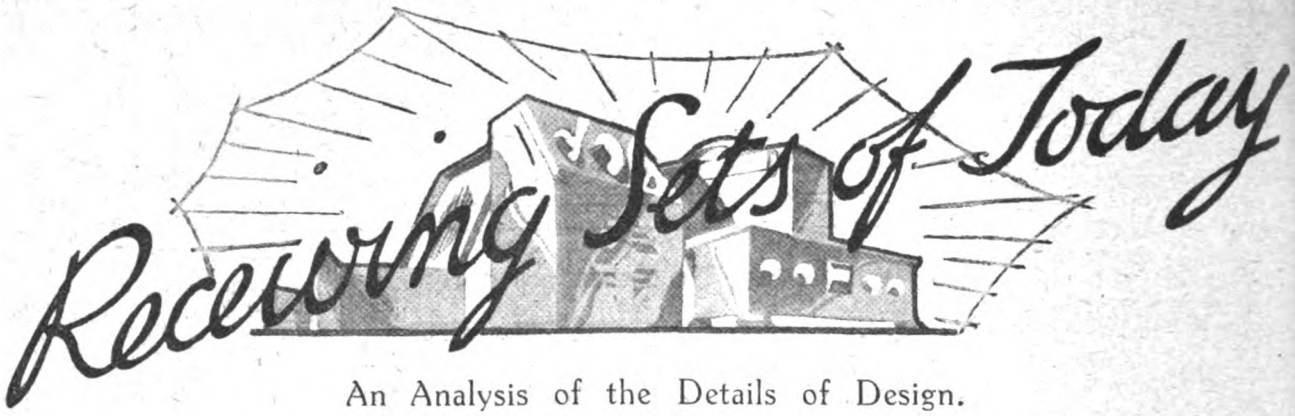
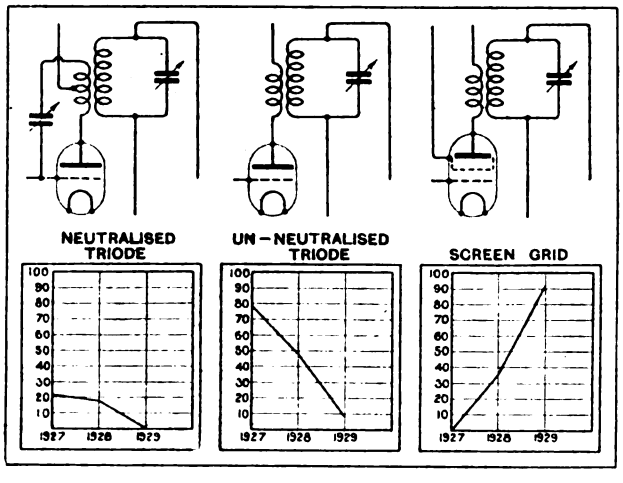
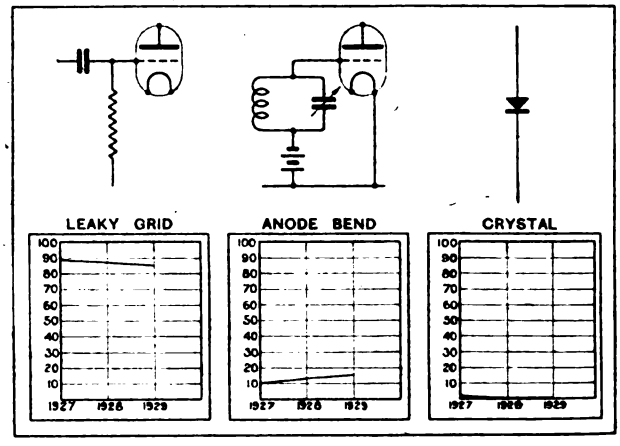


An Analysis of the Details of Design.

GREATER progress has been made over the past year than during any other similar period since broadcasting began. Periodically we say that radio receiver design is settling down, that the rate of progress is becoming slower and that there is shortage of new ideas. Then comes perhaps a small contribution to a temporarily standardised practice and a number of changes quickly follow. By way of example, we might quote the effect of the screen-grid valve, which when first introduced made but slow headway in spite of a manufacturing prejudice against the then adopted practice of using the neutralised triode. This journal did much to draw attention to that all-important property of the screen valve, the amount of residual capacity left after the introduction of the screening electrode and its effect upon amplification. It was shown numerically that a far greater degree of amplification could be obtained with the improved types of S.G. valves than by the alternative process of the neutralised triode. Confidence thus gained in the use of the S.G. valve has brought about its almost universal adoption. A moment's thought will reveal that this minor development has proved a starting-off point for a host of modifications in receiver design. Thus one S.G. stage effectively replaces two inefficiently-coupled triodes; two stable H.F. stages of enormous overall amplification is a new introduction, while complete screening, accompanied by all-metal construction throughout, is the recent trend. In fact, to the screen-grid valve can be attributed a drastic change in the



These graphs indicate a remarkable change in the method of H.F. amplification. The neutralised and un-neutralised triode have fallen from a combined total of 100% almost to extinction. In two years the use of the S.G. valve has risen to over 90 %.



Three out of every twenty sets are fitted with anode bend detectors. A slight upward trend in the use of this form of detection is to be noted.

appearance, general construction and operation of wireless sets and the performance expected of them. So absorbed are designers in carrying into effect these technical improvements that there is yet little evidence of the new conditions in the ether, occasioned by the regional scheme, having made their mark upon the build of our sets.

Three Hundred Sets Analysed.

In the following few pages are summarised the general details of design of the receiving sets obtainable to-day. As in other years, percentages have been determined from specifications as they are and not from the knowledge that many of the types will soon be passing to be replaced by more up-to-date models possessing details that would modify the figures. Our census is taken at a time of change, but, nevertheless, the upward and downward tendencies revealed can be accepted as a reliable guide, their significance being actually of greater

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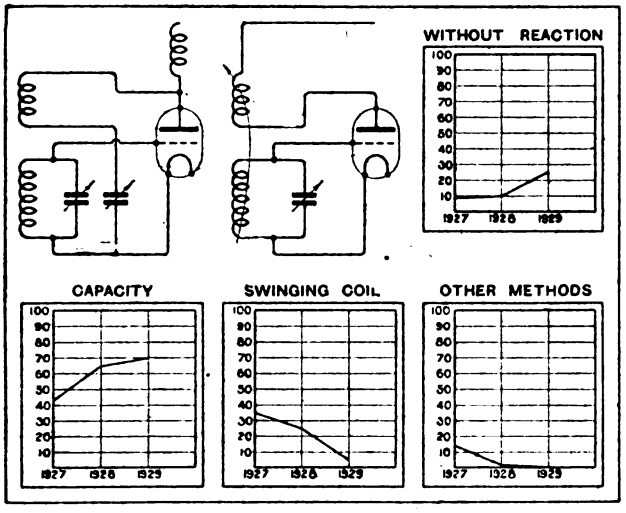
Receiving Sets of To-day.—

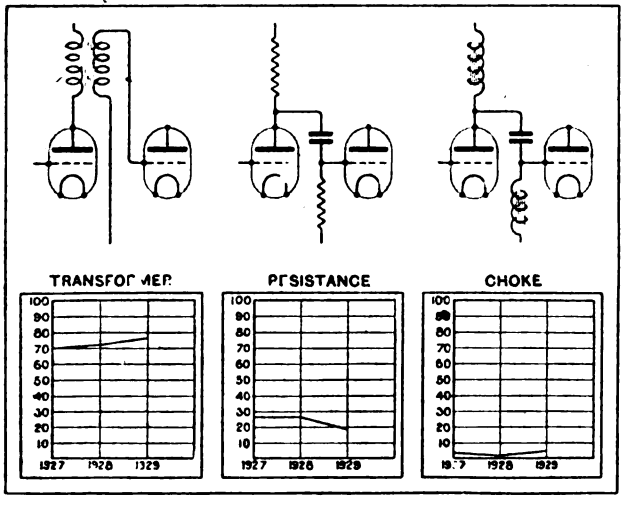
importance than is indicated. Data has been compiled, as far as is possible, in respect of some 300 sets, with the aid of information courteously furnished by the manufacturers, gleaned from trade lists, and in



Last year reaction was used in eighteen sets out of every twenty. Now reaction is only to be found in fifteen out of every twenty. The use of the capacity method of obtaining reaction is almost universal.

many cases actual scrutiny of the apparatus. Incidentally, the total number of sets is less this year than last, due to the withdrawal of obsolete types, many of which were superheterodynes, a reduction in the range of models, and, it is interesting to note, a slight falling-off in the number of set manufacturers.

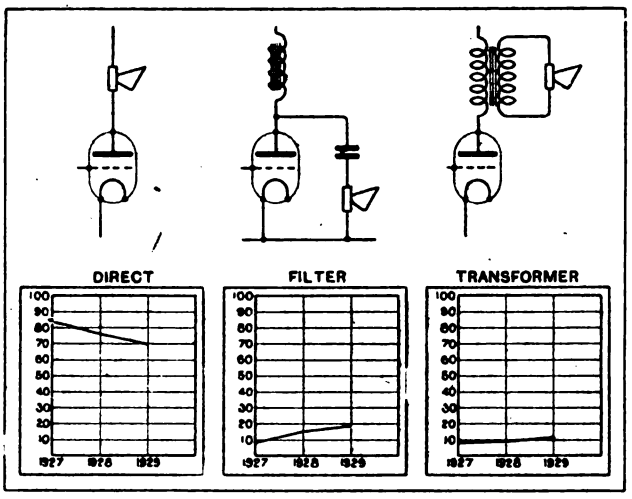
We will consider the receivers, item by item, from aerial to loud speaker. While it was confidently believed that as a result of the improving performance and rapid growth of the portable, combined with better and easier H.F. amplification, that the outdoor elevated



A small increase in the adoption of transformer coupling is due to a reduction in the number of L.F. stages and the increase in the use of the pentode.

aerial would disappear, there is, in fact, a slight percentage decrease in sets using entirely frame aerial. Regional conditions with generous signal strength over densely populated areas may modify this trend, and the decline in the use of the frame is probably due to the fall in the number of portables, with which it roughly numerically corresponds. It is probable, however, that the sensitivity-selectivity product for an outdoor aerial is better than for a frame when using a well-designed set embodying both filter and H.F. amplification. Among open aerial sets it is a growing practice to fit a small fixed capacity condenser in the aerial lead. This arrangement permits of the use of a single-coil aerial inductance in place of a transformer so that long- and short-waveband switching is simplified and some degree of selectivity achieved, together with an increase of signal voltage at the grid of the first valve. The reduction of aerial capacity provided by the series condenser simplifies ganging.

Whereas a year ago switching for long and short wavelengths was carried out by a variety of methods



Mains-operated sets are bringing about an increase in the provision of output filters and transformers.

it has now become general practice to merely short-circuit a loading coil. Portions of both primary and secondary windings are short-circuited in the case of H.F. transformers, and no longer is the somewhat difficult arrangement of series-parallel switching favoured. No single example has been noted of the use of specially designed low-loss coils, and even in the newer sets fitted with tuned screen-grid stages the inductances are mostly of a type introducing appreciable H.F. resistance. Such resistance is perhaps of small account in view of the other losses present, and these are generally of no greater value than is just required to give stability.

In a few of the up-to-date multi-valve sets, including screen-grid stages, the interstage screening is fairly thorough, but its completeness is obviously determined as a result of experiment, and takes into account convenience of manufacture.

Associated with the H.F. stages, one notes the bold bid made in the recently introduced sets to provide

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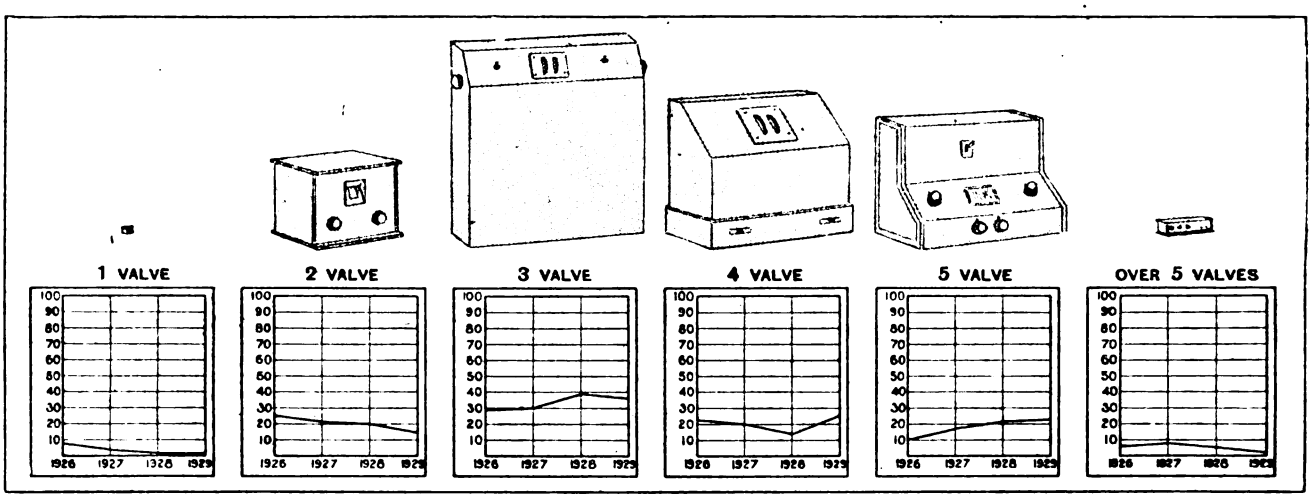
Receiving Sets of To-day.—

single dial tuning control demanding the ganged working of two or more tuning condensers. Some degree of flatness of tuning, combined with the precise matching of coils and condenser scales before assembly, would seem to be the system by which successful ganging is achieved. Trimming condensers, connected across the tuning condensers, are to be found in several sets, but their purpose can be merely that of bringing the stray parallel capacity up to a required minimum value being that on which the plate shape of the logarithmic scales were calculated. These trimmers do not compensate for lack of uniformity in the condensers themselves or differences in coils; they merely correct for circuit capacity differences. If, however, the coils are precisely matched and no provision is made for "slip ganging," logarithmic scales are not required, it merely being necessary to match the capacities, including stray capacity at all settings of the condensers. Ganging the condensers gives an apparent sharpness of tuning not it has dominated all other considerations of maintenance or performance. This feature is shared by the mains-operated receiver, and is combined with freedom from battery troubles and expense, while permitting of the use of valves of high performance and unrestricted as regards anode potentials and current. Thus there is an obvious prediction which an indication already confirms.

Fewer Sets with Reaction.

From the figures showing forms of detection one cannot overlook an increase in the use of anode bend detection, eve . though the advance is only small. Better H.F. amplifiers are largely responsible for the change, while the increased production of quality sets using perhaps a resistance-coupled L.F. stage has partly contributed. Regional conditions may further help the figure for anode-bend detection to advance, though the leaky grid method has many points in its favour, and will not fall back to any marked extent.



A slight decline in the manufacture of both two- and three-valve sets is offset by an increase in the number of receivers of four valves. There are contributory clauses which have combined to account for this change.

possessed by the individual stages, but it is possible that the production of a flat-topped resonance has been the aim in some of the sets in order to maintain a sufficient degree of selectivity without cutting down the sidebands, a necessary requirement for quality reception. Filters have not yet found their way into receivers of this class.

Aperiodic H.F. amplifiers are still to be found, but only in the older surviving portables. It cannot be denied that sets embodying two aperiodic stages have entirely satisfactory range-getting properties, but the amplification is essentially the result of a happy state of reaction control which this arrangement affords. The decline in the use of two aperiodic stages is marked, and is due partly to a preference for the single S.G. tuned amplifier and also to a decline on a percentage basis in the number of portables.

This latter observation is indicative of trend towards the replacing of the battery-operated portable by the all-mains set. Portables have appealed because they are self-contained, a feature so much sought after that

Reaction is to be found in 75 per cent. of the sets. This high figure is accounted for by the fact that it is provided in all two- and three-valve and portable sets. Here, again, can be seen the modifying effect of better H.F. amplification, in that this year's analysis reveals a very definite downward tendency in the use of reaction. It is, moreover, safe to forecast a rapid decline in the use of reaction under regional scheme conditions.

Little or no novelty has found its way into the L.F. amplifier, neither have the figures representing the types of intervalve couplings greatly changed. Increases in the use of anode bend detection and the production of expensive radio-gramophones might suggest a rise in favour of resistance coupling. On the other hand, the pentode valve has reduced the number of L.F. stages, while the input coupling is invariably a transformer. Although large sets are on the increase push-pull amplifiers have not grown in numbers. Parallel-connected output valves are included in the specifications of generous output amplifiers, and there are several examples of the use of pentodes in this way.

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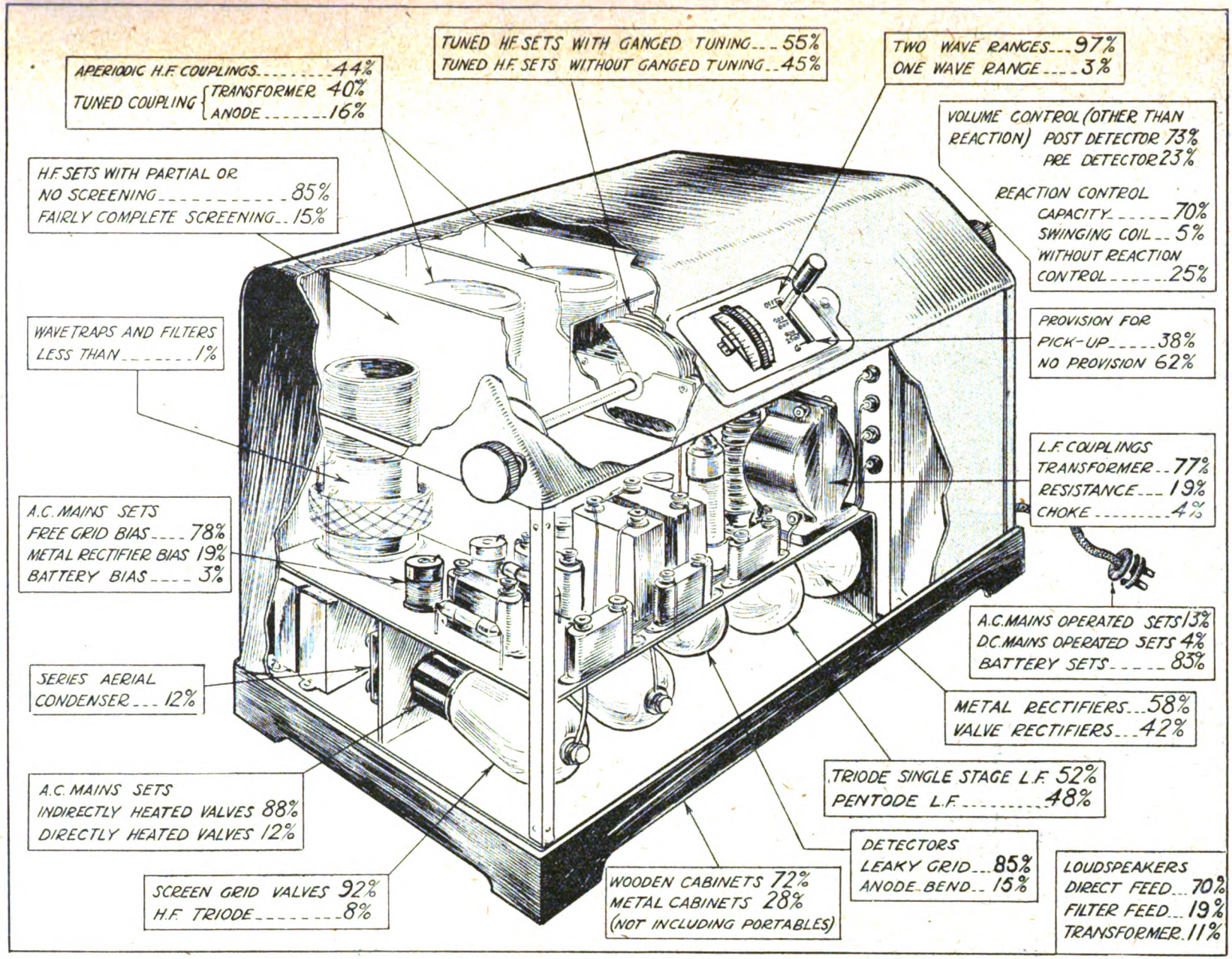

A modern receiver dissected to reveal present-day practice.

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Receiving Sets of To-day.—

After more than a year of popular interest in the electrical reproduction of gramophone records we find but a small increase in the percentage number of sets in which provision is made for the use of a gramophone pick-up. The figure given owes its increase mainly to the newly created radio-gramophones. Omission of the provision for the use of a gramophone pick-up does, however, undoubtedly mar the selling potentialities of sets.

Mains-operated sets are but few in number, yet their rapid growth indicates that they will become as popular as the portable which they are tending to replace. Their circuit systems have been dealt with in the preceding analysis. Unlike the portable, where the design is a random process of trial and error, and where all the established theoretical considerations are seemingly contravened, the mains set rigidly embodies in every detail all the best and most advanced principles. Sets for D.C. supply represent a small portion only of the total number of mains sets, and there is no evidence that the manufacturers intend to give much attention to this class of receiver. The requirements of the listener with D.C. supply are met by using a battery set with L.T. accumulator and D.C. eliminator and cells for grid biasing. Both indirectly and directly heated A.C. valves are to be found in the A.C. sets, one of the reasons given for the use of the directly heated valves being the easy conversion to battery working. Grid biasing is obtained in the majority of A.C. sets by a voltage dropped across a resistance carrying the anode current, the circuit becoming complicated by the earthing of the spindles of the tuning condensers. It is due to grid biasing problems that directly heated (battery) valves are used in the output stages of the A.C. models, a separate winding being provided for the purpose on the mains transformer. There is a wider range of battery than indirectly heated valves suitable for the output and these valves operate without hum when heated with A.C.

There is an appreciable increase in the inclusion of generous output stages, this having come about by the need for good quality and large undistorted A.C. output with loud speakers of the moving-coil type.

Sets of to-day are less like an assembly of well-known components than in preceding years. If progress were to become less rapid, then the enthusiast would soon find himself in the position of being able to procure a set as good, and probably cheaper, than he could build. Marked changes are, however, taking place now as hitherto, centring chiefly around the application of valve development. A fact that must not be overlooked is that every set is, with perhaps one exception, British built. While this position is, of course, mainly due to the foresight of the manufacturers in the matter of the administration of patents, it could not have been maintained with inferior gear.

Visiting a Power Station.

Condenser manufacture was dealt with in an interesting way by Mr. Haywood, of the Dubilier Co., in a lecture before the Alma (Bermondsey) Radio Society at a recent meeting. On October 29th members paid a visit to the local power station, which is being entirely rebuilt. Under the guidance of the engineers the party obtained a clear insight into the latest practice in electrical power distribution.

Attractive items in the early future include a visit to the local telephone exchange and a lecture and demonstration by a representative of the Mullard Company.

Hon. Secretary, Mr. A. J. Hopkins, 41, Trafalgar Road, S.E.15.

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A Mystery Debate.

The Incorporated Radio Society of Great Britain announces that the proceedings at the meeting on November 22nd will take the form of a debate the subject of which will be announced from the Chair. The meeting will be held at the Institution of Electrical Engineers, Savoy Place, W.C.2, at 6 p.m.

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From Battery to Mains.

"All Mains Receivers," a topic of special interest at the present time, was the subject of a lecture given before the Tottenham Wireless Society on November 6th by the Society's Technical Officer, Mr. J. Burns. Additional interest was given to this lecture because Mr. Burns treated his subject from the point of view of the home constructor; a few weeks previously the Society had listened to a lecture on the same subject by a representative of a firm producing these all-electric receivers commercially. Having experimented for two years with this class of set, and having made most of his material himself, the lecturer was able to draw upon a useful fund of practical experience which proved specially valuable to those members who are now making a change from battery to mains drive.

Hon. Secretary, Mr. W. Bodemeaid, 10, Bruce Grove, N.17

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The "Hit and Miss" Method.

The time when it was considered wonderful to ring a bell across the width of a room by wireless was recalled by Mr. A. K. Bentley in delivering the Presidential address on "The Progress of Radio" at the meeting of the Radio Experimental Society of Manchester on November 8th. The speaker emphasised that progress in radio had not been achieved by "hit and miss" methods, and if amateurs were to assist in the forward trend of wireless they must take the trouble to learn something about elementary physics and maths. At the Society's meeting on Friday next, November 22nd, Mr. R. M. Kay, B.Sc. (Tech.), will lecture on "The Thermionic Tube in Uses other than Radio." Visitors will be cordially welcomed.

Hon. Secretary, Mr. L. Fox, 23, Yew Tree Avenue, Alexandra Park, Manchester.

CLUB NEWS.

FORTHCOMING EVENTS.

WEDNESDAY, NOVEMBER 20th.

Edinburgh and District Radio Society.—At 8 p.m. At 16, Royal Terrace. Loud Speaker Night.

Muswell Hill and District Radio Society.—At 8 p.m. At Tollington School, Tetherdown N.10. Lecture and Demonstration: "Low-frequency Amplification," arranged by the Mullard Wireless Service Co., Ltd.

Queen's Park Radio Society.—At 8 p.m. At the Oddfellows' Hall, 593, Harrow Road, Paddington. Lecture by Mr. J. Josey.

THURSDAY, NOVEMBER 21st.

Ilford and District Radio Society.—Visit to Ilford Telephone Exchange.

Slade Radio (Birmingham).—At the Parochial Hall, Broomfield Road, Erdington. Junk Sale.

FRIDAY, NOVEMBER 22nd.

Incorporated Radio Society of Great Britain.—At 6 p.m. At the Institution of Electrical Engineers, Savoy Place, W.C.2. Debate (subject to be announced at meeting).

TUESDAY, NOVEMBER 26th.

Ryde Radio Society.—At 8 p.m. At Mount House Hall, George Street, Ryde, I.O.W. Lecture by Mr. R. M. Lucy (of Messrs. S. G. Brown, Ltd.).

Club Members as Critics.

A four-valve set alleged to be working unsatisfactorily was on view at the last meeting of the South Croydon and District Radio Society, and members felt it incumbent upon them to investigate the set to discover wherein it failed. A superficial inspection showed that the receiver was of the Everyman type, but here all resemblance stopped, for there were many radical alterations, particularly in the low frequency side. One "horrifying" feature, in the opinion of many present, was the inclusion of two resistance capacity stages instead of the conventional resistance coupling and L.F. transformer stages. The valves also came in for some caustic comment, but it can be said that the owner of the set, having had the courage to exhibit it, derived all the advice that he is likely to require for some time to come. Despite its imperfections, the maligned instrument provided good reception from the Continent as well as from Brookman's Park and 5GB.

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

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Difficulties Discussed.

The advantages of an open night when members can discuss difficulties in an informal fashion was demonstrated at a recent meeting of Slade Radio (Birmingham), at which many members discovered that they were able to augment their general wireless knowledge by studying each others' problems.

Full particulars regarding membership and the forthcoming activities of the Society can be obtained from the Hon. Secretary, Mr. W. E. Chilvers, 110, Hillaries Road, Gravelly Hill, Birmingham.

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In a Valve Factory.

Secrets of valve manufacture were disclosed by Mr. Clarke, of the Mullard Wireless Service Co., Ltd., at a meeting of the Battersea and District Radio Society on November 1st. The interest aroused by this constructive lecture was proved by the animated discussion which followed.

Meetings are held every Tuesday and Friday at 8 p.m. at the Battersea Men's Evening Institute, Latchmere Road, Lavender Hill, S.W.11. Hon. Secretary, Mr. H. E. Bottle, 27, Stormont Road, S.W.11.

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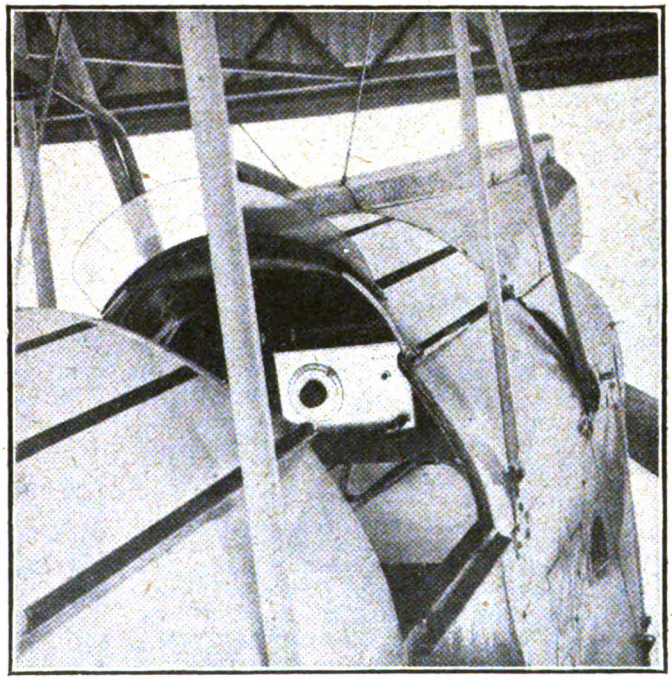
Flying Lessons by Wireless

New Aids for the Aerial Novice at Heston.

WHEN the learner at Heston Aerodrome is up in the air alone, relying for the first time on his own skill and coolheadness, he is sometimes faced with a sudden yearning for human society. He places a new valuation on the services of his former companion, the instructor.

For many flying hours before he ventures out solo he is kept on leading strings. The machine used is of the Moth or Avian class of light aeroplane, the instructor occupying the front seat and the pupil the rear seat usually occupied by the pilot. Conversation between the two is carried out by means of a voice pipe system which consists of two speaking tubes, one from pilot to pupil, and the other from pupil to pilot, with a suitable by-pass connection at a point in its length whereby pilot or pupil can hear his own speech without impairing the hearing of the other. After the pupil has done the required amount of dual training and he is considered sufficiently far advanced to fly by himself he is allowed to take up the machine on his own, and it is at this point that wireless equipment is particularly useful. All previous instruction having been given by means of the voice pipe, the psychological effect on the pupil can be appreciated if, when on his solo flight, he is still enabled to receive necessary instructions in the familiar voice of his instructor should he show signs of nervousness or lack of control of the machine. Aerial tuition at Heston is now being carried out with the aid of the G.A.6 light aircraft receiver, manufactured by Messrs. Alfred Graham. By means of the voice pipe attachment the output speech from this receiver is applied to the part of the voice pipe containing the by-pass tube, thus enabling the pupil to listen to the wireless reports or instructions without having to wear headphones.



The cockpit of an instructional plane, showing the wireless receiver.

The receiver operates from small aerials fixed between wing tips and tail in such a way that folding of the wings is not interfered with. Current is supplied from a small container holding the H.T. battery and an unspillable accumulator, connection to the set being made through armoured cable.

In the case of a fully qualified pilot this receiver is

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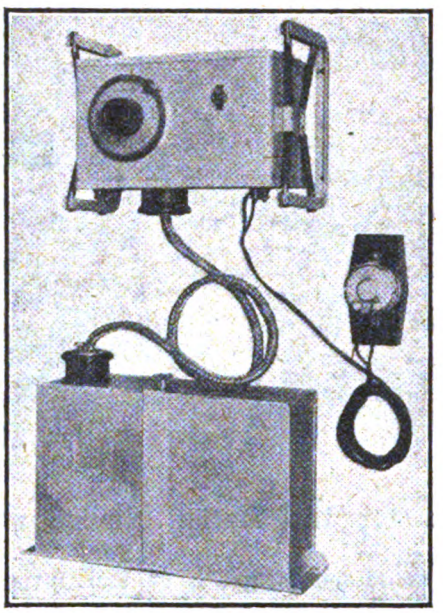
Flying Lessons by Wireless.—

particularly useful for receiving meteorological reports. The voice pipe arrangement enables both pilot and passenger to converse together and also to hear wireless reports.

The total weight of the complete outfit is about 18 lb., and the aerial system does not detract from the manœuvrability or aerobatic performances of the machine.

With regard to the ground station used in conjunction with this receiver that fitted at Heston is the ½ kW. intermediate air-port transmitter manufactured by Messrs. Alfred Graham and Co., Ltd. This outfit consists of a transmitter working on 764 metres, the wavelength which has been sanctioned by the Air Ministry for light aircraft training and meteorological transmissions. The transmitter provides either C.W., I.C.W. or phone, telephony being normally used for communication with the machine.

The transmitter is situated in the control tower of the aerodrome, and when A.C. mains are available the entire outfit is run direct from the supply; thus there is no running machinery and no noise. As Heston Aerodrome is at present on a D.C. supply it has been necessary to use a rotary convertor. The auxiliary apparatus in addition to the main transmitter consists of a receiver covering all wavelengths from 200-20,000 metres, a heterodyne oscillator for use in the reception of C.W., and a speech amplifier unit which provides the modulation voltage from a standard Amplion microphone.



The entire equipment on the plane, shown in this photograph, weighs only 18 lb. The lower cabinet houses the batteries. The earphone on the right is applied to the instructor's speaking tube when the pupil is flying alone.

The aerial system consists of twin lengths of phosphor-bronze wire at a height of about 55 feet, one end being supported on a steel lattice spar and the other on a mast on top of the control tower.

With this arrangement it is possible to take a microphone on the roof of the control tower, from where a view of the entire aerodrome may be obtained and instruction be given for all positions of the machine. It is also possible to obtain a view of other machines taking off and landing, so that any necessary warnings may be given.

As an example of the value of the aircraft receiver for meteorological purposes, the experience of a flying visitor to the recent Newcastle-on-Tyne Air Pageant is worth quoting.

On the Sunday morning after the pageant it was desired to start the return journey to Heston Aerodrome, but the weather at Newcastle was impossible owing to a thick fog, rain and drifting smoke. Whilst waiting, however, to see if the weather would clear Croydon was tuned-in on the receiver while sending a message to a machine on the cross-Channel service, indicating that although weather round Newcastle was bad, at a few miles to the south there was little or no fog, with quite good flying conditions. Backed up by this news the pilot took off from Newcastle, and made a perfectly good return journey to Heston.

Swiss Amateur Union.

A section of the International Amateur Radio Union has now been formed in Switzerland, under the presidency of M. H. Degler (HB9D), of the Radio Club of Zurich. The hon. secretary is M. W. Schneeberger (HB9G), whose station is at Fleurettes 20, Lausanne, and the traffic manager is M. Wuest (HB9C), also of Lausanne. Address communications to the U.S.K.A., Postfach, Zurich 20.

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R.S.G.B. Calibration Service.

Readers are reminded that calibration signals are transmitted on the second and fourth Sundays of each month, from Mr. G. W. Thomas' station, G5YK, at Cambridge, beginning at 10.00 G.M.T. with the call "RSGB RSGB DE G5YK," followed by a two-minute dash on 7050 kC. (42.55 metres). At 10.05 G.M.T. the call is repeated and is followed by a similar long dash on 7250 kC. (41.38 metres). The calibration transmission is preceded at 09.55 by the letter X, in morse, and a telephonic announcement that the service is about to begin, followed by a further announcement of the actual measured frequency of the two transmissions.

TRANSMITTERS' NOTES

Reports Welcomed.

Mr. J. Armstrong, 109, Rupert Street, Bolton, Lancs, transmits on 169 metres, from his station G5XM, at midnight on Saturdays and 11 p.m. on Sundays, and on 42 and 21 metres between 8 p.m. and 10 p.m. during the week. He will be glad if anyone hearing these signals will kindly send him reports.

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New Zealand Stations.

The following list supplements and corrects that published in the "Radio Amateur Call Book" for September :—

Auckland District.

ZL1AB S. G. Waite, 54, Marlborough St., Dominion Rd., Auckland.
ZL1AZ J. R. Sherson, 14, Stanley St., Hamilton.
ZL1BL J. S. Lynch, Ngaruawahia.
ZL1FD F. R. Booth, 28, Rosstrevor St., Hamilton
ZL1FE A. F. Wood, P.W. Station, Waihou.

Wellington District.

ZL2AH R. V. Roberts, 39, Scarborough Terrace, Wellington.
ZL2AL S. E. Brown, 32, Owen St., Wellington.
ZL2AS H. R. Boyle, Cunard Steamship Co., Ltd., G.P.O. Box 188, Wellington.
ZL2BC S. H. Perry, 89, Tiber St., Wellington.
ZL2GF J. O. Taylor, 248, The Terrace, Wellington.
ZL2GU J. C. East, 270, The Terrace, Wellington.

Canterbury District.

ZL3BD J. C. East, 326, Papanui Rd., Christchurch.
ZL3BF E. Prince, 76, Cobham Rd., Spreydon, Christchurch.
ZL3CB C. R. H. Taylor, 7, Rutland St., St. Albans.
ZL3CS E. B. Buckhurst, Jnr., 98, Office Rd., Merivale.
ZL3CY W. T. Smith, 28, Derby St., St. Albans.

Otago District.

ZL4AT J. Stone, 34, Grove St., Dunedin.
ZL4BM V. G. Whiteman, Puysegur Point Lighthouse, Otago.

New Call-Signs and Changes of Address.

G5VB A. F. Elton Bott, "Francisca," Barlow Rd., Hampton, Middlesex.
G15WD W. S. Davison, 42, Eglinton St., Portrush, Co. Antrim. (Change of address).
G6SV M. Savage, 144, Hoppers Rd., London, N.21. (Change of address).
G6TX J. Fynn, 24, The Broadway, Woodford Green, Essex. (Change of address).

France.

F8EX J. Denimal, 20, rue des Bouchers, Cambrai.
F8FP P. Moles, 17, rue Jean-Furguet, Bordeaux.
F8JF C. Pepin, 173, Bould. Péreire, Paris 17. (Change of address).
F8LN M. Raoult, Boite Postale, 4, Dinan. (Change of address.)

Sumatra.

PK4EO J. H. H. van Buijsen, c/o. Adm.-de Deli Mij, Medan.

Madagascar.

FB8HL (Tananarive) is cancelled.

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CURRENT TOPICS

Events of the Week in Brief Review.

VEST POCKET WIRELESS.

From Detroit comes the report that a pocket wireless set has been tested and found practicable for regular use by the local police. The set contains two valves, measures six inches by four inches, and is narrow enough to fit into a vest pocket. The aerial consists of a network of 175ft. of fine wire sewn into the back of the vest.

Tests are stated to have given clearly audible signals at a distance of seven miles from the Detroit police transmitter, KOP.

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DISCRIMINATING CRIMINALS.

Thieves who stole £80 worth of wireless goods from a Manchester shop last week had the choice of a wide range of sets, but selected only the latest models.

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EISTEDDFOD WIRELESS.

A reader writes to correct the statement in a recent issue that the wireless competition at next year's National Eisteddfod will be the first in the history of this event. A prize of £2 10s. was offered for a home-constructed wireless receiver in the Eisteddfod of 1925, though unfortunately there was only one entry!

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THE MONOPHONE.

Maj.-Gen. G. O. Squier, late of the U.S. Army, and famous for his inventions connected with "wired wireless," has won a decision at the U.S. Patent Office giving him priority in the invention of the "monophone." Using the ordinary telephone system, but not interfering with its normal functioning, the "monophone" provides subscribers with broadcast programmes on a frequency band "entirely above and out of the way of the band used by wired radio on power lines for broadcasting service."

Gen. Squier's claim is so broad that it is held to cover even "talking movies" in the house through a completely screened circuit with zero noise-level, due to the lead sheathing of the telephone cable.

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ANOTHER HEAVISIDE LAYER?

A woman applicant at Willesden Police Court recently complained that her neighbour's aerial was of the wrong wavelength, upsetting her washing and making it as black as soot.

THE WIRELESS LEAGUE.

Members of the Wireless League are cordially invited to attend the Annual General Meeting which will be held at the Royal Automobile Club, Pall Mall, S.W., on Friday, December 6th, at 3 o'clock. Sir Arthur Stanley will be in the chair.

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BEAM BROADCAST TO CANADA.

The Marconi-Mathieu multiplex beam service from Bodmin, operating at 16·575 metres, was used for relaying the broadcast of the Cenotaph service on Armistice Day to listeners in Canada, who heard the transmission from the broadcasting stations of the Canadian National Railways. On a previous occasion, when the beam station relayed the Thanksgiving Service in Westminster Abbey, Canadian listeners reported that the quality was equal to that of a first-class local broadcast.

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A BOOK OF VALVES.

To the student of modern valve design one of the most interesting publications of the moment is the new Osram Valve Catalogue issued by the General Electric Co., Ltd., Magnet House, Kingsway, W.C.2. In seventy-nine pages the whole range of Osram receiving valves is dealt with, each valve being illustrated and described. Characteristic curves and full working data are given in each case.

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ONE UNDER THE EIGHT.

There are 21,629,107 radio receiving sets in the world, according to the precise estimate of the Electrical Equipment Division of the U.S. Department of Commerce. The authors of this delicate computation state that there is one receiving set for every 12½ persons in the United States, one for every 53 in Europe, and one for every 88 in the world.

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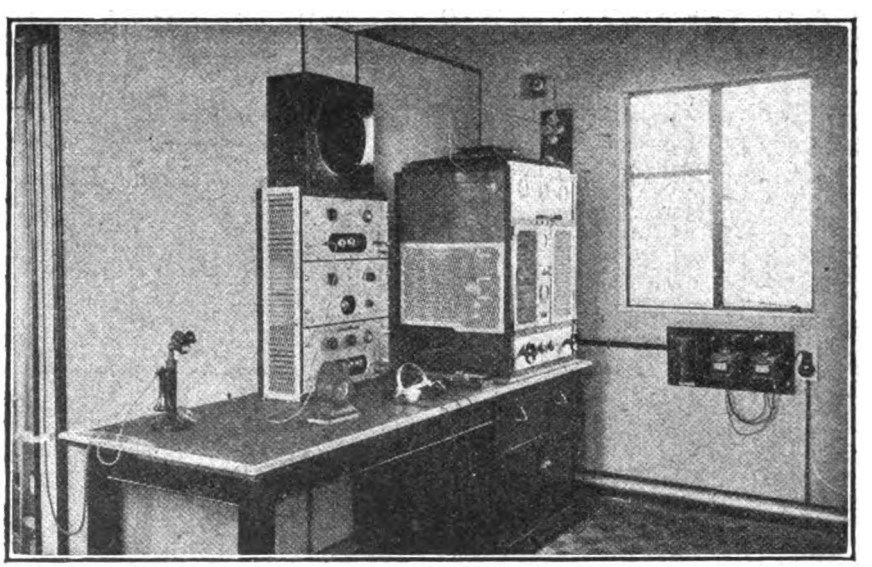
CLUB SECRETARIES, PLEASE NOTE.

For the benefit of radio societies and schools, the Marconiphone Company has prepared three interesting lectures, each illustrated by lantern slides, which are suitable for delivery by a society member. The subjects dealt with are: (*a*) Screen-grid valves and circuits; (*b*) A.C. valves and circuits; and (*c*) public speech and music amplifiers.

Particulars can be obtained from the Marconiphone Co., Ltd., Department I.D., 210-212, Tottenham Court Road, London, W.1.



FLYING LESSONS BY WIRELESS. The transmitter installed at Heston Aerodrome by Messrs. Alfred Graham for use in instructing solo fliers. The above photograph taken in the control tower, shows the transmitter on the right. The smaller panel on the left contains the receiver, heterodyne unit and speech amplifier.

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BUYERS' GUIDE, 1929-30.

"The Wireless World" Reference List of Receiving Sets.

Manufacturer.	Name of Set.	Valves and Couplings.											Current Supply.	Grams. Pick-up.	Price.	Remarks.
		H.F.	Coupling.	H.F.	Coupling.	H.F.	Coupling.	Det.	Coupling.	L.F.	Coupling.	L.F.	Output.			£ s. d.	
Adey Radio, Ltd., 99, Mortimer Street, London, W.1.	Adey One (*P*)	—	—	—	—	—	—	LG	—	—	—	—	—	B	—	4 2 6	Inclusive. Frame aerial incorporated, 7 lb.
,, ,, ,,	,, Two (*P*)	—	—	—	—	—	—	LG	Tr	P	—	—	Tr	B	PP	10 0 0	,, 16 lb.
,, ,, ,,	,, Three (*P*)	—	—	—	—	T	Ap	LG	Tr	P	—	—	—	—	—	12 12 0	,, Oak or mah. Lacquer £2 10s. extra, 16½ lb.
	,, Four (*P*)	—	—	T	Ap	T	Ap	LG	Tr	P	—	—	Tr	B	—	14 14 0	,, ,, ,, ,, ,, 17 ,,
Aeonic Radio, 90, Regent Street, London, W.1.	A.C. Mains Radio-Gramo (*RG*).	—	—	—	—	—	—	*LG	—	*T	—	*T	Tr	AC	GP	50 8 0	Inclusive mah. or walnut.
,, ,, ,,	Suitcase 5 (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	16 16 0	,, 15½ × 12½ × 8½in. 27 lb.
,, ,, ,,	Screened Grid 4 (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	—	19 19 0	,, ,, ,, ,, ,,
,, ,, ,,	Transportable 5 (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	16 16 0	,, 16 × 15½ × 8in. 28 lb.
,, ,, ,,	Battery Driven Radio-Gramo (*RG*).	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	GP	26 5 0	,,
,, ,, ,,	All Mains S.G.4	—	—	—	—	*SG	TA	*LG	Tr	*T	Tr	T	D	AC	PP	26 5 0	,,
,, ,, ,,	Two Valve Mains "A.C.".	—	—	—	—	—	—	*LG	Tr	T	—	—	D	AC	PP	12 15 0	,,
C. Creswick Atkinson, 35B, High Street, Bedford.	Nulli Secundus Rover, S.G.4 (*P*)	—	—	—	—	SG	TA	LG	—	T	—	T	D	B	PP	22 1 0	Inclusive. Suitcase, 10 × 12 × 15½in., 28 lb.
,, ,, ,,	Nulli Secundus Universal Five (*P*).	—	—	T	TA	T	—	LG	—	T	—	T	D	B	PP	16 16 0	,, ,, ,, ,,
,, ,, ,,	Nulli Secundus All Mains Three (*P*).	—	—	—	—	SG	TA	LG	—	P	—	—	D	AC	PP	29 8 0	,, ,, ,, 35 lb.
Automatic Radio Mfg. Co., Gosford Road, Beccles, Suffolk.	Radiogramophone (*RG*) ..	—	—	—	—	—	—	LG	Tr	T	Tr	T	—	B	—	—	——
Avon Radio Mfg. Co., Long Ashton, Nr. Bristol.	Mains Three	—	—	—	—	—	—	*T	—	*T	—	T	D	AC	PP	20 0 0	Set and valves only.
	Mains Four	—	—	—	—	*SG	—	*T	—	*T	—	T	D	AC	PP	35 0 0	Set, valves and L.S. only.
Ernest J. Baty, 157, Dunstable Road Luton.	Baty Four	—	—	—	—	T	TG	LG	Tr	T	Tr	T	F	B, AC or DC	—	36 0 0	Complete installation.
S. W. Bligh, 1/2, North Lane, Canterbury.	S.G./3 Receiver	—	—	—	—	SG	TT	AB	RC	P	—	—	F	DC	PP	25 0 0	Including valves only; 2 Pentodes paralleled in output.
,, ,, ,,	Duovalve Pedestal	—	—	—	—	—	—	LG	Tr	T	—	—	F	DC	PP	10 15 0	Including batteries and valves.
Bowyer-Lowe Co., Ltd., Radio Works, Letchworth, Herts.	Portable V. (*P*)	—	—	T	RC	T	Ap	LG	Tr	T	Tr	T	D	B	—	16 16 0	Inclusive. 18½ × 14½ × 8½in. 31 lb.
	Pentavox Three	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	—	10 0 0	Including valves and royalties.
,, ,, ,,	Radiogramophone (*RG*) ..	—	—	—	—	SG	TT	AB	RC	P	—	—	D or F	B, AC or DC	—	39 0 0	Battery model. Including valves and royalties.
																56 0 0	D.C. mains model. ,, ,, ,,
																65 0 0	A.C. ,, ,, ,, ,,
,, ,, ,,	Pentavox Two	—	—	—	—	—	—	LG	Tr	P	—	—	D	B	—	6 8 0	Including valves and royalties.
,, ,, ,,	Vox Populi III.	—	—	—	—	SG	TT	AB	—	P	—	—	F	DC	—	28 0 0	,, ,, ,, ,,
,, ,, ,,	,, ,, ,,	—	—	—	—	SG	TA	AB	—	P	—	—	F	AC	—	33 0 0	,, ,, ,, ,,
,, ,, ,,	,, ,, Four	—	—	—	—	SG	TT	AB	RC	T	Tr	T	D	B	PP	24 0 0	,, ,, royalties and frame aerial.
British General Mfg Co., Ltd., Brockley Works, Brockley, London, S.E.4.	3-valve Receiver	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	PP	15 0 0	Set and royalties only.
British Radio Gramophone Co., Ltd., 77, City Road, London, E.C.1.	"Rover" Super Screened 4 Transportable (*P*).	—	—	—	—	SG	TT	LG	Tr	T	Tr	T	D	B or AC	—	19 19 0	Inclusive. Oak Cabinet, 19½ × 14 × 9in. 26lb.
																21 0 0	,, Mah. ,, ,,
,, ,, ,,	"Rover" 5 (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	PP	16 16 0	Inclusive, 19½ × 14 × 9in., 30 lb. ,,
,, ,, ,,	Craigweil 3-valve Self-contained.	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	12 12 0	Including batteries, valves, L.S. and royalties.
,, ,, ,,	Craigweil Radiogramophone (*RG*).	—	—	—	—	SG	TT	LG	Tr	P	—	—	D	B	—	37 10 0	,, ,, ,, ,, ,,
S. G. Brown, Ltd., Western Avenue, North Acton, London, W.3.	3-valve S.G. Receiver, Types A and B.	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	12 7 6	Type A. Set and L.S. only. Mains model £20 10s.
																9 7 6	Type B. Set only. Mains model £17 10s.
Brownie Wireless Co. of Great Britain, Ltd., Nelson Street Works, Mornington Crescent, London, N.W.1.	Brownie 2-valver	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	2 10 0	Set only.
	Dominion Three	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	PP	5 17 6	,,
	,, Console	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	PP	9 0 0	Set and L.S. only.
Fred Bulmer, 4, Carlton Terrace, Scarborough.	Carlton S.G. III.	—	—	—	—	SG	TA	T	—	T	—	—	F	B	—	12 12 0	Including valves.
Bullphone, Ltd., 38, Holywell Lane, London, E.C.2.	Nightingale Three	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	9 0 0	Set complete.
Burgoyne Wireless, Ltd., 34A, York Road, London, N.1.	Screened Grid 3	—	—	—	—	SG	TT	LG	Tr	T	—	—	D	B	—	10 10 0	,,
	"Screened Four" (*P*)	—	—	—	—	SG	TA	LG	RC	T	Tr	P	D	B	—	25 4 0	Inclusive. Hide suitcase, 15 × 15 × 9in., 30 lb.
,, ,, ,,	Pentode Model (*P*)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	P	D	B	—	19 19 0	,, Leather suitcase, 15½ × 12½ × 8in., 26 lb.
	All Mains S.G. Transportable (*P*).	—	—	—	—	SG	TA	LG	RC	T	Tr	T	D	AC	—	36 15 0	Including valves and royalties.

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Burndept Wireless (1928), Ltd., Eastnor House, Blackheath, London, S.E.8.	Screened Four	—	—	—	—	SG	TA	LG	RC	T	Tr	T	D	B	PP	27 18 6	Including valves and royalties.
	A.C. Screened Seven	—	—	*SG	TA	*SG	TA	*AB	RC	*T	Tr	T	Tr	AC	PP	37 16 0	Oak ,, ,, ,, ,, Push-pull output stage.
																38 17 0	Mah. ,, ,, ,, ,, ,, ,, ,,
,, ,, ,,	A.C. Ethogram (*RG*)	—	—	*SG	TA	*SG	TA	*AB	RC	*T	Tr	T	Tr	AC	—	52 10 0	Oak ,, ,, ,, ,, ,, ,, ,,
																53 11 0	Mah. ,, ,, ,, ,, ,, ,, ,,
,, ,, ,,	Universal Screened Five	—	—	—	—	SG	TA	LG	RC	T	Tr	T	Tr	B or AC	PP	31 10 0	Battery model ,, ,, ,, ,, ,,
																40 19 0	Mains ,, ,, ,, ,, ,,
,, ,, ,,	Ethogram (*RG*)	—	—	—	—	SG	TA	LG	RC	T	Tr	T	D	B	—	42 0 0	Oak. Complete, including royalties.
																44 2 0	Mah. ,, ,, ,,
,, ,,	Screened Portable (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	PP	19 19 0	Inclusive. Leather suitcase 14½ × 14½ × 8in., 30 lb.
Burne-Jones & Co., Ltd., 296, Boroug h High Street, London, S.E.1.	A/C 2	—	—	—	—	—	—	*LG	Tr	*T	—	—	F	AC	PP	16 10 0	Including valves and royalties.
	Universal Three	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	—	18 0 0	,, ,, ,, ,, 15–2000 metres.
,, ,, ,,	Transportable (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	18 18 0	Inclusive.
,, ,, ,,	A/C 3	—	—	—	—	*SG	TA	*LG	Tr	*T	—	—	F	AC	PP	25 0 0	Including valves and royalties.
C. F. & H. Burton, Progress Works, Bernard Street, Walsall.	"Empire 3"	—	—	—	—	—	—	*LG	RC	*T	Tr	*T	D	AC	—	11 5 0	Including valves and royalties.
,, ,,		—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	—	5 10 0	,, batteries, valves and royalties.
Cantophone Wireless Co., 310, Regent Street, London, W.1.	Cantophone Radiogramophone (*RG*).	—	—	—	—	—	—	*LG	RC	*†	RC	*†	F	AC or DC	GP	89 5 0	DC model inclusive. † 4RC coupled LF stages.
																99 15 0	AC ,, ,, † ,, ,, ,,
																125 0 0	Double turntable model with "Fade-over" switch and 2 L.S.
,, ,, ,,	Cantophone "Junior" Radiogramophone (*RG*)	—	—	—	—	—	—	*LG	RC	*T	RC	T	F	AC or DC	GP	55 0 0	DC model inclusive.
																65 0 0	AC ,, ,,
,, ,, ,,	Cantophone 2-valve Portable (*P*).	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	10 10 0	Inclusive. Leather attaché case 12 × 9 × 5in. 10 lb.
Celebritone, Ltd., 72, Oxford Street, London, W.1.	Celebro (*P*)	—	—	T	Ap	T	Ap	AB	RC	T	Tr	T	Tr	B	—	12 0 0	Inclusive. Rexine suitcase. Hide 12s. extra.
Churchmans, Ltd., 79, Maidenburgh Street, Colchester.	New Mascot 330	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B or DC	—	10 10 0	Battery model, including batteries, valves and royalties.
																15 17 6	Mains ,, ,, valves and royalties.
,, ,,	New Mascot 230	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	7 10 0	Including batteries, valves and royalties.
City & General Radio Co., Ltd., 46, Watling Street, London, E.C.4.	Radio-gram (*RG*)	—	—	—	—	—	—	*LG	—	*T	—	*T	Tr	AC or DC	GP	50 8 0	Inclusive. Parallel output valves.
,, ,, ,,	City Super 3	—	—	—	—	SG	TA	LG	Tr	P or T	—	—	D	B	PP	9 9 0	Including valves and royalties.
Classic Radio & Gramophone Co., Ltd., 25, Eccleston Street, London, S.W.1.	Ariel (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	16 16 0	Inclusive. Suitcase or cabinet 15½ × 12½ × 8½in. 25 lb.
Climax Radio Electric, Ltd., Haverstock Works, Parkhill Road, Hampstead, London, N.W.3.	Chello-Set	—	—	—	—	—	—	*LG	Tr	*P	—	—	—	AC	PP	9 17 6	Including valves and royalties.
E. K. Cole, Ltd., "Ekco Works," London Road, Leigh-on-Sea, Essex.	P.2	—	—	—	—	—	—	LG	Tr	P	—	—	Tr	DC	PP	12 17 6	,, ,, ,, ,,
	P.2	—	—	—	—	—	—	*LG	Tr	P	—	—	Tr	AC	PP	12 17 6	,, ,, ,, ,,
,, ,, ,,	SG.P.3	—	—	—	—	*SG	TT	*LG	Tr	P	—	—	Tr	AC	PP	21 0 0	,, ,, ,, ,,
,, ,, ,,	SG.P.3	—	—	—	—	SG	TT	LG	Tr	P	—	—	Tr	DC	PP	21 0 0	,, ,, ,, ,,
Columbia Graphophone Co., Ltd., 92, Clerkenwell Road, London, E.C.1.	Radio Gramophone (*RG*)	SG	TT	SG	TT	SG	TT	AB	RC	T	Tr	T	Tr	AC	GP	126 0 0	Inclusive. Parallel output valves.
	Table Model 304	SG	TT	SG	TT	SG	TT	AB	RC	T	—	—	Tr	B, AC or DC	—	83 0 0	Mains models complete.
																27 0 0	Battery model complete.
,, ,, ,,	Columbia Portable 303 (*P*)	—	—	T	TA	T	Ap	LG	Tr	T	Tr	T	D	B	—	17 17 0	Oak. Complete. Adaptor supplied for conversion to mains.
																19 19 0	Leather cloth ,, ,, ,, ,,
Contal Radio, Ltd., 8, Spital Square, London, E.C.1.	Silvert Five (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	Tr	B	—	12 12 0	Inclusive. Suitcase 15½ × 13½ × 9½in. 26lb.
,, ,,	Four (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	Tr	B	—	18 18 0	,, 17½ × 15 × 7½in. 30lb.
Cooks Wireless Co., Ltd., C.W.C. Works, Ipswich.	C.W.C. Popular. (*P*)	—	—	T	Ap	T	Ap	LG	—	T	—	T	D	B	—	16 10 0	Inclusive with turntable, 18 × 16 × 7½in. 26 lb.
	C.W.C. Radiogramophone (*RG*).	—	—	—	—	SG	TT	LG	—	T	—	P	D	B	GP	45 0 0	Including valves and royalties.
,, ,,	C.W.C. Famous Five (*P*)	—	—	T	Ap	T	Ap	LG	—	T	—	T	D	B	—	21 0 0	Inclusive with turntable, 15 × 15 × 7½in. 28 lb.
S. Dagnall, Ltd., 420, Stratford Road, Sparkhill, Birmingham.	"S.D.L. Two"	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	—	—
	"S.D.L. Screened Three".	—	—	—	—	SG	TT	LG	Tr	P	—	—	D	B	—	—	—
Detex Distributors, Ltd., 66, Victoria Street, London, S.W.1.	Burlington (*P*)	—	—	T	Ap	T	Ap	LG	—	T	—	T	D	B	—	16 5 0	Inclusive. Suitcase 15½ × 13 × 8½in. 25 lb.
Dorien Wireless Co., Ltd., 315, Regent Street, London, W.1.	Super Screened Four (*P*)	—	—	—	—	SG	TG	LG	Tr	T	Tr	T	D	B	—	19 19 0	Suitcase type, 30 lb.
Dubilier Condenser Co. (1925), Ltd., Ducon Works, Victoria Road, North Acton, London, W.3.	Westminster (*PRG*)	—	—	SG	TG	SG	Ap	LG	Tr	P	—	—	D	B	GP	80 9 0	Inclusive, 20 × 18 × 9½in. 58 lb.
	All Electric D.C.3	—	—	—	—	*SG	TT	*AB	Tr	*T	—	—	F	DC	—	25 0 0	Including valves and royalties.
,, ,,	A.C.3	—	—	—	—	*SG	TT	*AB	Tr	*T	—	—	D	AC	—	25 0 0	,, ,, ,, ,,
J. Dyson & Co., Ltd., 2, Coleman Street, London, E.C.2.	Godwinex Radiogramophone, Model N (*RG*).	—	—	—	—	*SG	TA	*LG	RC	*T	Tr	*T	F	AC	GP	55 0 0	,, ,, ,, ,, Frame aerial incorporated.
,, ,, ,,	Godwinex 5-valve, Model D (*P*).	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B	PP	16 16 0	Inclusive.
,, ,, ,,	Godwinex 3-valve All Mains, Model O.	—	—	—	—	*SG	TA	*LG	Tr	*T	—	—	F	AC	PP	23 10 0	Including valves and royalties.
Eagle Engineering Co., Ltd., Eagle Works, Warwick.	Chakophone Junior Three	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	8 7 9	,, ,, ,, ,,
,, ,, ,,	,, Radiogramophone (*RG*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	GP	31 10 0	,, ,, ,, ,,
,, ,, ,,	,, Junior Two	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	5 9 9	,, ,, ,, ,,
,, ,, ,,	,, Warwick Two	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	6 10 0	,, ,, ,, ,,
,, ,, ,,	,, ,, ,, Pedestal	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	8 5 0	,, ,, ,, ,,
,, ,, ,,	,, ,, ,, A.C. All Mains.	—	—	—	—	—	—	LG	Tr	T	—	—	F	AC	PP	15 15 0	,, ,, ,, ,,
,, ,, ,,	,, ,, Five (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	PP	16 16 0	Inclusive. Walnut cabinet 17 × 13 × 7in. 34 lb.
,, ,, ,,	,, ,, Junior Five (*P*).	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	14 14 0	,, ,, suitcase 17 × 9 × 12in. 26 lb.
,, ,, ,,	,, ,, ,, Four (*P*)	—	—	T	Ap	T	Ap	LG	Tr	P	—	—	D	B	—	13 13 0	,, ,, ,, ,, ,,

ABBREVIATIONS.—*RG* = Radio Gramophone. *P* = Portable. *Valves:* **SG** = Screen Grid. **TG** = Tuned Grid. **T** = Triode. **P** = Pentode. * = Directly or Indirectly Heated Mains Valves. *Coupling:* **TA** = Tuned Anode. **TG** = Tuned Grid. **TT** = Tuned Transformer. **Ap** = Aperiodic. **RC** = Resistance. **Tr** = Transformer. **Ch** = Choke. *Method of Rectification:* **AB** = Anode Bend. **LG** = Leaky Grid. *Loud Speaker Feed:* **D** = Direct. **F** = Filter. **Tr** = Transformer. *Current Supply:* **B** = Batteries. **AC** or **DC** = Mains Unit, Incorporated. *Gramophone Pick-up Arrangements:* **GP** = Pick-up included. **PP** = Provision for Pick-up.

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Buyers' Guide, 1929-30.—

Manufacturer.	Name of Set.	Valves and Couplings. H.F.	Coupling.	H.F.	Coupling.	H.F.	Coupling.	Det.	Coupling.	L.F.	Coupling.	L.F.	Output.	Current Supply.	Gram. Pick-up.	Price. £ s. d.	Remarks.
Edison Bell, Ltd., 62, Glengall Road, London, S.E.15.	All Mains Radio-Gram (*RG*)	—	—	—	—	*SG	TT	*AB	RC	*T	Tr	*T	Tr	AC	GP	65 0 0	Including valves and royalties. D.C. model with rotary converter, £19 extra.
,, ,, ,,	Bijou Two	—	—	—	—	—	—	LG	Tr	P	—	—	D	B	—	3 12 6	Set only.
,, ,, ,,	Pedestal Three	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	PP	9 12 6	,, and L.S. only.
,, ,, ,,	Compact Three	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	PP	7 10 0	Oak. Set and L.S. only.
																8 8 0	Mah. ,, ,, ,,
																10 10 0	Lacquer,, ,, ,,
,, ,, ,,	Homestead Three	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	PP	6 7 6	Oak. Set only.
																7 0 0	Mah. ,,
																8 8 0	Lacquer ,,
,, ,, ,,	Maison S.G. Three (*P*)	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	PP	8 10 0	Set only, 18×15×7½in. 35 lb.
,, ,, ,,	Regent Four	—	—	—	—	T	TT	AB	RC	T	Tr	T	D	B	—	20 0 0	Oak. Set only.
																22 10 0	Mah. ,,
,, ,, ,,	Console Four	—	—	—	—	T	TT	AB	RC	T	Tr	T	D	B	—	16 16 0	Oak. Set and L.S. only.
,, ,, ,,	Picnic Portable (*P*)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B	—	16 16 0	Inclusive, 13½×13½×10in. 26 lb. De Luxe finish, £1 1s. extra.
Edison Swan Electric Co., Ltd., 1A, Newman Street, London, W.1.	3-valve Battery Receiver	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	9 12 6	Including valves and royalties.
	,, All Electric Receiver	—	—	—	—	*SG	TA	*LG	Tr	P	—	—	F	AC or DC	PP	21 0 0	,, ,, ,, ,,
,, ,, ,,	All Electric AC Transportable (*P*).	—	—	—	—	*SG	TA	*LG	RC	*T	Tr	*T	D	AC	PP	31 10 0	Inclusive. Oak cabinet 13½×13½×9½in., 1 watt AC output.
,, ,, ,,	B.T.H. 4-valve	—	—	SG	TA	SG	TA	LG	Tr	T	—	—	D	B	—	21 0 0	Including valves and royalties.
Electric Lamp Service Co., Ltd., 39/41, Parker Street, London, W.C.2.	Stal (*P*)	—	—	T	RC	T	Ap	LG	Tr	T	Tr	T	D	B	—	13 13 0	Inclusive. Oak cabinet 16×8×12in. 26 lb.
Ellancee Radio, Ltd., Shardlow, Nr. Derby.	Ellancee Standard Two	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	7 1 1	Including valves and royalties.
	,, ,, Three	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	10 12 0	,, ,, ,, ,,
,, ,, ,,	,, S.G. Three	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	9 9 0	Set only.
,, ,, ,,	,, Radiogram (*RG*)	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	GP	22 0 0	Inclusive.
Elven Mains Receiver Co., 34, Church Street, London, W.8.	Elven Mains	—	—	—	—	—	—	*LG orAB	Tr	T	—	—	D	AC or DC	—	12 10 0	Including valves and royalties.
,, ,, ,,	Elven Mains Portable (*P*)	—	—	—	—	SG	TA	LG	RC	T	Tr	T	D	AC or DC	PP	28 7 0	Inclusive, 17×17×7in. 30 lb.
Empire Electric Co., 10, Fitzroy Square, London, W.1.	Metropolis Portable (*P*)	†	—	†	—	†	—	LG	—	P	—	—	D	B	—	31 10 0	Inclusive. Suitcase 13×12×5in. 22 lb. † 5-valve Super-Het.
,, ,, ,,	,, Table Grand	†	—	†	—	†	—	LG	—	P	—	—	D	B	—	31 10 0	,, † 5-valve Super-Het.
Falk, Stadelmann & Co., Ltd., 83/93, Farringdon Road, London, E.C.1.	Efescaphone "Waterloo" de Luxe.	—	—	—	—	*SG	TA	*LG	Tr	*T	—	—	D	AC	—	25 0 0	Including valves, L.S. and royalties.
,, ,, ,,	,, ,, ,,	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	20 10 0	,, batteries, valves, L.S. and royalties.
,, ,, ,,	Efescaphone "Waterloo"	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	—	12 0 0	Set and royalties only.
,, ,, ,,	,, "Repton"	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	8 15 0	,, ,, ,,
,, ,, ,,	,, "New Wolfe"	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	—	6 2 6	,, ,, ,,
,, ,, ,,	,, "Eton"	—	—	—	—	*SG	TA	*LG	Tr	*T	—	—	D	AC	—	22 0 0	Including valves and royalties.
,, ,, ,,	,, "Ascot" (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	—	21 0 0	Inclusive. Leatheroid suitcase 16½×15½×10in.
																23 0 0	Hide ,, ,, ,,
Jonathan Fallowfield, Ltd., 61/2, Newman Street, London, W.1.	Corner Cabinet Radio-Gram (*RG*).	—	—	—	—	SG	TT	LG	Tr	T or P	—	—	D	B	GP	40 0 0	Including batteries, valves and royalties.
Ferranti Ltd., Hollinwood, Lancs.	A.C. 31	—	—	—	—	*SG	TT	*LG	Tr	T	—	—	Tr	AC	PP	26 0 0	Including valves and royalties.
A. G. Franklyn, Pegasus Works, Camden Terrace, Leeds.	Pegasus Scout (*P*)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B	PP	17 17 0	Inclusive, 16×16×8in. 28 lb.
	,, Radiogramophone (*RG*)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B	GP	31 10 0	,,
Gambrell Radio, Ltd., Buckingham House, Buckingham Street, London, W.C.2.	All Electric Two	—	—	—	—	—	—	LG	Tr	T	—	—	F	AC or DC	—	13 15 0	D.C. Model, including valves and royalties.
																17 10 0	A.C. ,, ,, ,, ,,
	,, ,, Three	—	—	—	—	SG	TA	LG	Tr	P	—	—	F	AC or DC	PP	22 0 0	D.C. ,, ,, ,, ,,
																25 0 0	A.C. ,, ,, ,, ,,
,, ,, ,,	,, ,, Transportable. (*P*)	—	—	—	—	SG	TA	LG	Tr	P	—	—	F	AC or DC	PP	29 0 0	D.C. ,, inclusive.
																32 0 0	A.C. ,, ,,
,, ,, ,,	,, ,, Four	—	—	—	—	SG	TA	LG	Tr	P	—	—	F	AC or DC	—	33 5 0	D.C. model, including valves and royalties, 2 pentodes in parallel.
																30 15 0	A.C. ,, ,, ,, ,,
,, ,, ,,	Radio Gramophone (*RG*)	—	—	—	—	—	—	LG	Tr	P	—	—	F	AC or DC	GP	59 17 0	D.C. Model, inclusive. Oak, 2 pentodes in parallel.
																61 19 0	,, ,, ,, Mah. ,, ,,
																67 4 0	A.C. ,, ,, Oak ,, ,,
																69 6 0	,, ,, ,, Mah. ,, ,,
,, ,, ,,	,, Novotone (*RG*)	—	—	—	—	SG	TA	LG	Tr	P	—	—	F	AC or DC	GP	72 9 0	D.C. ,, ,, Oak ,, ,,
																64 11 0	,, ,, ,, Mah. ,, ,,
																84 0 0	A.C. ,, ,, Oak ,, ,,
																86 2 0	,, ,, ,, Mah. ,, ,,

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Garnett, Whiteley & Co., Ltd., Lotus Works, Mill Lane, Liverpool.	Lotus S.G.P. All Mains	—	—	—	—	*SG	TT	*LG	Tr	P	—	—	D	AC	PP	21 0 0	Including valves and royalties.
,, ,, ,,	,, ,, Battery Model	—	—	—	—	SG	TT	LG	Tr	P	—	—	D	B	PP	13 15 0	,, ,, ,, ,,
,, ,, ,,	,, Portable (*P*)	—	—	SG	Ap	SG	TA	LG	Tr	P	—	—	D	B	—	19 19 0	Inclusive. Suitcase 18½×15½×12½in. 35 lb.
	,, All Mains Transportable (*P*)	—	—	—	—	*SG	TT	*LG	Tr	P	—	—	D	AC	—	25 4 0	Inclusive. Oak.
																26 5 0	,, Mah. or walnut.
General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.	Gecophone Two-valve All Electric.	—	—	—	—	—	—	*LG	Tr	T	—	—	F	AC	—	15 0 0	Including valves and royalties.
,, ,, ,,	,, Three-valve ,,	—	—	—	—	*SG	TA	*LG	Tr	T	—	—	F	AC	—	25 0 0	,, ,, ,, ,,
,, ,, ,,	,, ,, ,, ,, (*P*)	—	—	—	—	*SG	TA	*LG	Tr	P	—	—	F	AC	—	28 0 0	Inclusive 11½×17×17½in. 40 lb.
,, ,, ,,	,, S.G. Four (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	—	24 3 0	,, leather case, 10½×15½×15½in. 35 lb.
,, ,, ,,	,, S.G. Three	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	18 18 0	Including batteries, valves and royalties.
,, ,, ,,	,, "World Wide" S.G.4	—	—	SG	TT	SG	TT	AB	Tr	T	—	—	D	B	—	28 0 0	,, ,, ,, ,,
Gent & Co., Ltd., "Faraday" Works, Leicester.	Radiomatic Pentode	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	PP	20 16 0	Including valves and royalties.
	,, All Mains 2-valve..	—	—	—	—	—	—	*LG	Tr	P	—	—	Tr	AC	PP	11 10 0	,, ,, ,,
,, ,, ,,	,, ,, ,, S.G.P.	—	—	—	—	*SG	TT	*LG	Tr	P	—	—	Tr	AC	PP	20 0 0	(Approximate) ,, ,, ,,
,, ,, ,,	,, Radiogramophone (*RG*).	—	—	—	—	*SG	TT	*LG	Tr	T	Tr	T	Tr	AC	GP	55 0 0	Inclusive. LS 6a output and moving coil.
F. E. Godfrey, 3, New End, Hampstead, London, N.W.3.	Radiogramophone (*RG*) ..	—	—	*SG	TT	*SG	TT	*AB	Tr	*T	RC	T	Tr	AC or DC	GP	From 120 0 0	,, L.F. valves in push-pull following detector.
Gollings & Ayres, 21, The Broadway, Bedford.	Wellington V. (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	15 0 0	Inclusive. Oak or Suitcase.
,, ,, ,,	,, Radio Gram (*RG*) .	—	—	—	—	*SG	TA	*AB	RC	*T	Tr	T	Tr	AC	GP	15 15 0	,, Mah.
																60 0 0	,,
Gould, Harper & Co., Tatnam Road, Poole.	Melo Melodia Three	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	—	9 5 6	Including valves and royalties.
,, ,, ,,	,, ,, ,, ...	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	5 10 0	Set and royalties only.
Graham Amplion, Ltd., St. Andrew's Works, Slough.	Amplion Radiogramophone (*RG*).	—	—	—	—	*SG	TA	*LG	RC	*T	Tr	T	F	AC	GP	120 0 0	Inclusive. Oak. Paralleled output stage.
																125 0 0	,, Mah. ,, ,, ,,
,, ,, ,,	,, Standard Mains	—	—	—	—	*SG	TA	*LG	RC	*T	Tr	T	F	AC	PP	50 0 0	,, Paralleled output stage.
,, ,, ,,	,, 4-valve	—	—	—	—	SG	TA	LG	RC	T	Tr	T	F	B	PP	25 0 0	,,
J. G. Graves, Ltd., Westville, Durham Road, Sheffield.	"Vulcan" 3 S.G.	—	—	—	—	SG	TT	LG	Tr	T	—	—	D	B	—	12 2 3	Complete receiving equipment including royalties.
A. W. Griffin & Co., Ltd., Old Factory, Bates Hill, Redditch.	,, 2.....	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	7 10 0	,, ,, ,, ,, ,,
,, ,, ,,	Terralto 2-valve	—	—	—	—	—	—	LG or AB	Tr	T or P	—	—	D	B	—	3 17 6	Set only.
	,, 3-valve	—	—	—	—	SG	TT	LG or AB	Tr	T or P	—	—	D	B	—	5 17 0	,, ,,
Halcyon Wireless Co., Ltd., 313/319, Regent Street, London, W.1.	De Luxe S.G.4 (*P*).....	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	—	29 8 0	Inclusive. Suitcase 16×15×10½ in. 33 lb.
	,, Cabinet 5 (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	33 12 0	,, Walnut cabinet 18½×14½×8½in. 40 lb.
Harlie Bros., Balham Road, Lower Edmonton, London, N.9.	Harlie Radio-Gramophone (*RG*).	—	—	—	—	—	—	LG	Ch	T	Tr	T	Tr	AC or DC	GP	From £11 8 to 152 10 0	,, Output 2 LS 5a valves in parallel.
Harmony, Ltd., Great Portland Street, London, W.1.	Harmony (*P*)	—	—	T	Ap	T	Ap	AB	RC	T	Tr	T	Tr	B	—	14 14 0	,, Suitcase 14½×12×8½in. 27 lb.
Hart Collins, Ltd., 38A, Bessborough Street, London, S.W.1.	"Passport" Mains Transportable (*P*).	—	—	—	—	*SG	TA	*LG	Tr	*T	—	—	F	AC or DC	PP	32 10 0	Including valves and royalties.
,, ,, ,,	"Passport" 4-valve S.G. de Luxe (*P*).	—	—	—	—	SG	TG	AB	Tr	T	Tr	T	D	B	—	23 10 0	Inclusive. Walnut suitcase 14½×12×8½in 25 lb.
,, ,, ,,	"Passport" 4-valve S.G. (*P*).	—	—	—	—	SG	TG	AB	Tr	T	Tr	T	D	B	—	21 5 0	,, Hide ,, ,, ,,
E. R. Harveyson, Hatherton Terrace, Hendon Lane, London, N.3.	Minstrel (*P*)	—	—	T	—	T	—	LG	—	T	—	T	D	B	—	16 16 0	Inclusive, 15×13½×7½in. 24 lb.
W. J. Henderson & Co., Ltd., 351, Fulham Road, London, S.W.10.	Pedestal Radio-Gramophone (*RG*)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B, AC or DC	GP	40 0 0	Inclusive. Battery model, frame aerial incorporated.
																49 15 0	,, D.C. Mains ,, ,, ,, ,,
																57 15 0	,, A.C. ,, ,, ,, ,,
,, ,, ,,	Type S. (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	26 5 0	,, Mah. cabinet, 17½×13×10in. 31 lb.
,, ,, ,,	,, P. (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	24 5 0	,, ,, ,, 14½×13½×7½in. 24½ lb.
,, ,, ,,	,, T. (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	17 17 0	,, Suitcase 9½×15×12½in. 28 lb.
,, ,, ,,	,, U. (*P*)	—	—	—	—	—	—	LG	Tr	P	—	—	D	B	—	11 11 0	,, Fabric covered cabinet 8½×8×12in. 19½ lb
Holt & Crompton, 196, Shaftesbury Avenue, London, W.C.2.	Lion "Cub" (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	16 16 0	,, Walnut or mah. cabinet 16½×11½×7½ in. 26 lb.
	,, "Monarch" (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	25 4 0	,, ,, mah. or fabric-covered cabinet 16½×12½×8in. 32 lb.
Ieranic Electric Co., Ltd., Elstow Works, Bedford.	Short Wave Screened Grid Receiver.	—	—	—	—	SG	TA	LG	Tr	T	RC	T	D	B	—	34 16 0	Including valves and royalties, 10–85 metres.
,, ,, ,,	Short Wave Neutrosonic Receiver.	†	—	†	—	†	—	†	—	†	—	†	D	B	—	28 7 0	Oak, including valves and royalties. Mah. £3 extra. † 6-valve Super-Het.
,, ,, ,,	AC/3 Cabinet Model (*RG*).	—	—	—	—	*SG	TA	*LG	Tr	T or P	—	—	F	AC	GP	48 10 0	Oak inclusive. Mah. £3 extra.
,, ,, ,,	AC/3 Table Model	—	—	—	—	*SG	TA	*LG	Tr	T or P	—	—	F	AC	PP	25 0 0	Oak, including valves and royalties. Mah. £1 extra.
,, ,, ,,	Neutrosonic de Luxe Radio-Gramophone (*RG*).	†	—	†	—	†	—	†	—	†	—	†	F	AC	GP	114 10 0	Oak inclusive. Mah. £3 extra. † 8-valve Super-Het.
,, ,, ,,	Neutrosonic Seven Table Model.	†	—	†	—	†	—	†	—	†	—	†	D	B	PP	52 0 0	Including valves and royalties. † 7-valve Super-Het.
,, ,, ,,	Neutrosonic Seven Transportable Model (*P*).	†	—	†	—	†	—	†	—	†	—	†	D	B	—	69 0 0	Inclusive. Leatherette cases. † 7-valve Super-Het.
,, ,, ,,	Universal Receiver (*P*)....	—	—	SG	TG	SG	AP	LG	RC	T	Tr	T	D	B	—	33 2 6	,, Suitcase.

ABBREVIATIONS.—*RG* = Radio Gramophone. *P* = Portable. *Valves:* **SG** = Screen Grid. **TG** = Tuned Grid. **T** = Triode. **P** = Pentode. * = Directly or Indirectly Heated Mains Valves. *Coupling:* **TA** = Tuned Anode. **TG** = Tuned Grid. **TT** = Tuned Transformer. **Ap** = Aperiodic. **RC** = Resistance. **Tr** = Transformer. **Ch** = Choke. *Method of Rectification:* **AB** = Anode Bend. **LG** = Leaky Grid. *Loud Speaker Feed:* **D** = Direct. **F** = Filter. **Tr** = Transformer. *Current Supply:* **B** = Batteries. **AC** or **DC** = Mains Unit, Incorporated. *Gramophone Pick-up Arrangements:* **GP** = Pick-up included. **PP** = Provision for Pick-up.

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Buyers' Guide, 1929-30.—

Manufacturer.	Name of Set.	Valves and Couplings. H.F.	Coupling.	H.F.	Coupling.	H.F.	Coupling.	Det.	Coupling.	L.F.	Coupling.	L.F.	Output.	Current Supply.	Gramo. Pick-up.	Price. £ s. d.	Remarks.
Itonia Gramophones, Ltd., 58, City Road, London, E.C.1.	Screened-Grid IV. (*P*)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21 0 0	Inclusive, hide suitcase.
" " "	Autocrat V. (*P*)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16 16 0	"
	Screened-Grid IV. Radio-gramophone (*RG*).	—	—	—	—	—	—	—	—	—	—	—	—	—	—	39 18 0	"
W. H. Janes, 202, Dale Street, Chatham.	Janettephone 2	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	12 0 0	Including batteries, valves, L.S. and royalties.
	" S.G.3	—	—	—	—	SG	TT	LG	Tr	T	—	—	Tr	B	—	24 0 0	" valves, eliminator, L.S. and royalties.
Kolster-Brandes, Ltd., Cray Works, Sidcup, Kent.	KB 161—KB169	—	—	—	—	*SG	TT	*LG	Tr	P	—	—	D	AC	PP	17 10 0	Including valves and royalties.
" " "	KB103—KB156 (*P*)	—	—	—	—	SG	TT	LG	Tr	T	Tr	T	D	B	—	18 18 0	Inclusive, oak or leather case 17×16½×9½in. 36 lb.
" " "	KB163	—	—	—	—	SG	TT	LG	Tr	P	—	—	—	—	PP	10 15 0	Including valves and royalties.
	Brandesets IIIA and IIIB .	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	7 10 0	IIIA oak, including valves and royalties.
" " "	KB Radio Gramophone (*RG*)	—	—	—	—	*SG	TT	*LG	Tr	T	—	—	D	AC	GP	8 17 6	IIIB " " " " with battery compartment.
" " "	KB.182 " " (*RG*)	—	—	—	—	SG	TT	LG	Tr	T	—	—	D	B	GP	49 10 0	Including valves and royalties.
S. A. Lamplugh, Ltd., Kings Road, Tyseley, Birmingham.	Silver Ghost A.C. S.G.3 ..	—	—	—	—	*SG	—	*LG	—	*T	—	—	D	AC	—	39 10 0	" batteries, valves and royalties.
	" " Chassirad	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	27 10 0	Inclusive.
" " "	Popular III.	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	4 15 0	Set and royalties only.
	Silver Ghost Popular III.	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	5 7 6	" " " "
	" " Standard III. .	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	7 2 6	" " " "
Eric J. Lever (Trix), Ltd., 8/9, Clerkenwell Green, London, E.C.1.	Trix Five (*P*)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B	PP	17 17 0	Set and accessories only. Walnut or mah. cabinet, 17×15½×8½in. 30 lb. Special adaptor for use with Mains.
" " "	" Two (*P*)	—	—	—	—	—	—	LG	Tr	P	—	—	D	B	—	10 10 0	Set and accessories only. Leather cloth suitcase 13½×13½×7in. 16 lb.
" " "	" Portette (*P*)	—	—	—	—	—	—	LG	—	—	—	—	—	B	—	5 15 6	Complete with headphones, leather cloth case 8×6×6in. 6½ lb.
" " "	" All Mains 3.....	—	—	—	—	—	—	*AB	RC	*T	Tr	*T	F	AC	PP	18 10 0	Inclusive.
" " "	" Radio Gram "A" (*RG*)	—	—	—	—	—	—	*AB	RC	*T	Tr	*T	F	AC	GP	47 5 0	"
Lissen, Ltd., Lissenium Works, Worple Road, Isleworth, Middlesex.....	S.G.3	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	8 0 0	Set and royalties only.
	Lissenola Five (*P*).....	—	—	T	TT	T	Ap	LG	Tr	T	Tr	T	D	B	PP	19 19 0	Inclusive. Hide, oak or mah. suitcase.
" " "	" Radio Gramophone 1/S.G. (*RG*).	—	—	—	—	SG	TA	LG	Tr	P	—	—	Tr	B, AC or DC	GP	16 16 0	" Leather cloth suitcase.
" " "	" Radio Gramophone 2/S.G. (*RG*).	—	—	SG	TA	SG	TA	LG	Tr	P	—	—	Tr	B, AC or DC	GP	From £30 to £70	"
Liverpool Radio Supplies, 64, Myrtle Street, Liverpool.	Unifiex 3.....	—	—	—	—	*SG	TA	*LG	Tr	P	—	—	F	AC	PP	From £30 to £70	" Pentodes in parallel in moving coil models.
Lowe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15.	" 5 (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	PP	18 0 0	"
	R.O.433	—	—	—	—	—	—	LG	—	†	—	†	D	B	PP	15 0 0	" Oak or mah. cabinet 18½×17×8in. 28 lb.
" " "	O.E.333.....	—	—	—	—	—	—	AB	—	†	—	†	D	B	PP	3 10 0	Including valve and royalty, capacity controlled reaction. † Triple valve.
London Electrical Co., 1, Sherborne Lane, King William Street, London, E.C.4.	Lecodyne G.4 (*RG*)	—	—	—	—	SG	TT	LG	RC	T	Tr	T	D	B	PP	3 3 0	Including valve and royalty. No reaction. † Triple valve.
	" G.3. (*RG*)	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	GP	19 19 0	Including batteries, valves, L.S. and royalties.
	" 1930M.M.	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	—	14 14 0	" " " "
Loudspeaker Co., Ltd., 38, Palmer Street, London, S.W.1.	4-valve S.G. Trans-portable (*P*)	—	—	—	—	SG	Ap	LG	Tr	T	Tr	T	Tr	B	PP	8 0 0	" valves and royalties." "
Claude Lyons, Ltd., 76, Old Hall Street, Liverpool.	Lyons-Ferranti 5-valve....	—	—	—	—	SG	TT	AB	Tr	T	Tr	T	Tr	B	PP	36 15 0	Including valves, L.S., royalties and A.C. or D.C. eliminator 18×17×8in. 32 lb.
" " "	Chronicle-Lyons 8-valve Super-Het.	†	—	†	—	†	—	†	—	†	—	†	F	B	PP	27 10 0	Including valves and royalties. Push-pull L.F. A.C. model £10 10s. extra, D.C. model £7 extra.
																33 10 0	Including valves and royalties. † Super-Het. A.C. model £10 extra, D.C. model £7 extra.
M.P.A. Wireless, Ltd., Radio Works, High Road, Chiswick, London, W.4.	All Electric Three	—	—	—	—	*T	TT	*AB	Tr	P	—	—	F	AC	PP	26 5 0	Including valves and royalties.
L. McMichael, Ltd., Slough, Bucks.	Screened Dimic 3	—	—	—	—	SG	TG	LG	Tr	P	—	—	F	B	PP	19 19 0	Including valves and royalties, with special provision for eliminator.
" " "	" "	—	—	—	—	*SG	TG	*LG	Tr	T	—	—	F	AC	PP	29 8 0	" " " "
" " "	Super Range Transportable Four. (*P*)	—	—	—	—	SG	TG	LG	Tr	T	Tr	T	D	B	—	27 6 0	Inclusive. Table model with special adaptor for eliminator
" " "	Super Range Four (*P*)	—	—	—	—	SG	TG	LG	Tr	T	Tr	T	D	B	—	23 2 0	Inclusive. Leather suitcase 15½×15×9in. 30 lb. with special adaptor for eliminator.
"	Super Screened Four (*P*) .	—	—	SG	Ap	SG	TG	LG	Tr	P	—	—	D	B	—	36 15 0	Inclusive. Walnut case 18×15½×7in. 35 lb. with special adaptor for eliminator.

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" " "		—	—	—	—	—	—	LG	Tr	T or P	—	—	D	B or AC	—	10 3 3	Battery model including valves and royalties.
	" 23A	—	—	—	—	—	—	LG	Tr	T or P	—	—	D	A.C.	—	16 4 3	A.C. model " " " "
														B or AC		12 13 3	Battery " " " L.S. and royalties.
" " "	" 34 (S/W.)	—	—	—	—	—	—	LG	RC	T	Tr	T	D	A.C.	—	18 10 3	A.C. " " " "
" " "	" 39	—	—	—	—	SG	TA	LG	Tr	T or P	—	—	D	B	—	22 10 0	Including valves and royalties, 12–3,000 metres.
														B or AC	PP	13 0 0	Battery model, including valves and royalties.
														A.C.		21 0 0	A.C. " inclusive.
" " "	" 44	—	—	SG	TA	SG	TA	AB	RC	T or P	—	—	D	B or A.C.	—	22 10 0	Battery model, including valves and royalties.
																30 0 0	A.C. " inclusive.
" " "	" 47	—	—	—	—	SG	TA	AB	RC	T	RC	T	D	AC	PP	24 0 0	Inclusive.
" " "	" 45 (P)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	18 18 0	" Oak cabinet 14×14½×7½in. 28 lb.
" " "	" 56	SG	TA	SG	TA	SG	TA	AB	RC	T or P	—	—	D	B or AC	PP	30 7 0	Battery model. Including valves and royalties.
																35 0 0	A.C. " Inclusive.
" " "	" 61	SG	TA	SG	TA	SG	TA	AB	RC	T	RC	T	D	B	—	52 10 0	Set and royalties only, dials calibrated in wavelengths.
" " "	" 82	†	—	†	—	†	—	†	—	†	—	†	D	B	—	53 0 0	" " " " † 8-valve Super-Het.
																70 17 6	With complete equipment.
Montague Radio Inventions & Development Co., Ltd., 117/119, Regent Street, London, W.1.	Beethoven S.G. Super Four (P).	—	—	T	Ap	SG	TA	LG	Tr	P	—	—	D	B	—	26 5 0	Inclusive. Walnut cabinet 19×14½×9in. 34 lb.
	" Q.C.R. (P)	—	—	T	—	T	—	LG	—	T	—	T	D	B	—	22 1 0	" Hide attaché case 9½×14½×9in. 26 lb. With special reaction.
National Electric Co., Ltd., 10/14, Beak Street, London, W.1.	De Luxe 5 (P)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	15 15 0	Inclusive. 8×12×10½in. 27 lb
Neophone Engineering Co., 8, Garrick Street, London, W.C.2.	Neophone A. (P)	—	—	T	—	T	—	LG	—	T	—	T	D	B	—	15 15 0	Set complete less royalties. Oak 15½×13×9½ in. 28 lb.
																16 5 0	" " " " Mah. " " "
C. H. P. Nutter, 245, Selhurst Road, South Norwood, London, S.E.25.	Mains Three (RG)	—	—	—	—	*SG	TG	*LG	Tr	*T	—	—	F	AC	GP	36 15 0	Inclusive.
	Standard Two	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	9 9 0	Including batteries, valves, L.S. and royalties.
Ormond Engineering Co., Ltd., Ormond House, Rosebery Avenue, London, E.C.1.	Suitcase Four (P)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	—	16 16 0	Inclusive, 16½×13×9in. 28 lb.
	" Five (P)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	15 0 0	" " " "
	Five Valve Cabinet (P)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	15 0 0	Oak " 18½×14½×8½in. 30 lb. Mah. or walnut 15s. extra.
Orth-o-Dyne Radio & Electric Co., 63, Shaftesbury Street, London, N.1.	Orth-o-Dyne Five (P)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	PP	16 16 0	Inclusive. Hide suitcase 15½×13×10½in. 30 lb.
	" Transportable (P)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	15 15 0	" Mah. cabinet 14½×14½×8½in. 28 lb.
Pandona, Ltd., 184, Ashton Road, Birmingham.	Pandona Radio-Gram. S.G. IV. (RG)	—	—	—	—	SG	TT	LG	Tr	T	Tr	T	Tr	B	GP	From 44 2 0	Inclusive. Provision for Mains Unit.
" " "	Pandona Radio-Gram V. (RG)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	Tr	B	GP	From 42 0 0	" " " "
" " "	Pandona Screen Grid Four (P).	—	—	—	—	SG	TT	LG	Tr	T	Tr	T	D	B	—	18 18 0	Including valves and royalties. Leather suitcase 17×10×8in. 30 lb.
" " "	Pandona Portable Five (P)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	16 16 0	Including valves and royalties. Polished walnut case 17×13×7in. 28 lb.
Partridge, Wilson & Co., Loughborough Road, Leicester.	Davenset Transportable Five (P).	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	18 18 0	Inclusive. Walnut cabinet 15½×15½×8in. 24 lb.
Alfred Pearson, 80A, Newland Avenue, Hull.	"Perakon"	—	—	—	—	—	—	*LG	Tr	P	—	—	F	AC	—	12 10 0	Including valves and royalties.
	"	—	—	—	—	SG	TT	*AB	Tr	P	—	—	F	AC	—	16 15 0	" " " "
"Phantestra" (Renn's Gramophone & Wireless), Ltd., 2/4, Tottenham Road, Dalston, London, N.1.	Radio-Gramophone (PRG)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B	GP	24 3 0	Inclusive. Oak. 11×18×15½in. 40 lb.
	Phantestra Five (P)	—	—	T	Ap	T	Ap	LG	RC	T	Tr	T	D	B	—	15 15 0	" " 10×15½×12in. 27 lb.
" " "	Phantestra Home Model (RG).	—	—	SG	TA	T	Ap	LG	RC	T	Tr	T	F	B, AC or DC	GP	37 10 0	Battery model, inclusive.
																42 0 0	Mains models "
" " "	Phantestra S.G.3 (RG)	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	GP	26 5 0	Inclusive.
" " "	Rennotra S.G.3	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	PP	26 5 0	" with mechanical gramophone.
Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2.	Type 2501	—	—	—	—	*SG	TA	*LG	Tr	P	—	—	D	AC	—	16 10 0	Inclusive, for use with H.T. mains unit.
	" 2802	—	—	—	—	SG	TA	LG	Tr	T	Tr	P	D	B	PP	30 0 0	" 10–2,400 metres.
	" 2502	—	—	—	—	SG	TA	LG	Tr	P	—	—	D	B	—	15 0 0	"
" " "	" 2511	—	—	*SG	TA	*SG	TA	*LG	Tr	P	—	—	Tr	AC	PP	37 10 0	"
	" 2515	—	—	—	—	—	—	*LG	Tr	P	—	—	Tr	AC	PP	12 10 0	"
	" 2514	—	—	—	—	SG	TA	LG	Tr	P	—	—	Tr	AC	PP	23 0 0	"
C. Haddon Poupard & Co., Ltd., Thermion Works, Ilford, Essex.	Thermion Auto Electrical Gramo-Radio (RG).	—	—	—	—	SG	TA	AB	RC	T	Tr	T	Tr	AC or DC	GP	From 57 15 0 to 120 15 0	Inclusive. Paralleled output stage.
" " "	Thermion All Electric	—	—	—	—	—	—	AB	Tr	T	—	—	Tr	AC or DC	PP	—	" " "
" " "	Thermion Five (P)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	PP	22 1 0	Inclusive. Walnut attaché case.
Power Equipment Co., Ltd., Kingsbury Works, The Hyde, Hendon, London, N.W.9.	Kingswan 3 (P)	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	9 9 0	Inclusive. Fabric covered case 22 lb.
Precision Radio Mfg. Co., Ltd., Board School Road, Woking, Surrey.	Screened Grid Four Transportable (P).	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	PP	26 5 0	Including valves and royalties.
" " "	Radio Three	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	PP	6 10 0	Set only.

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Manufacturer.	Name of Set.	Valves and Couplings. H.F.	Coupling.	H.F.	Coupling.	H.F.	Coupling.	Det.	Coupling.	L.F.	Coupling.	L.F.	Output.	Current Supply.	Gramo. Pick-up.	Price. £ s. d.	Remarks.
Pye Radio, Ltd., Radio Works, Cambridge.	Type 25/C. (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	23 10 0	Inclusive. Walnut cabinet 15×15×7in. 26 lb. Provision for A.C. eliminator.
,, ,, ,,	All Electric Three	—	—	—	—	*SG	TT	*AB	Tr	*T	—	—	F	AC	PP	25 0 0	Including valves and royalties.
,, ,, ,,	Screened Grid Four	—	—	—	—	SG	TT	AB	RC	T	Tr	T	F	B	PP	19 10 0	,, ,, ,,
,, ,, ,,	Presentation Two	—	—	—	—	—	—	LG	Tr	T	—	—	—	B or AC	PP	12 10 0 17 10 0	Inclusive. Battery model." ,, Mains ,,
,, ,, ,,	Popular Two	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	4 17 0	Set and royalties only.
Quadruple Valve Co., Ltd., 1, Hood Street, Northampton.	"Really Portable" (*P*)	—	—	T	Ap	T	Ap	LG	—	†	—	†	D	B	—	12 12 0	Inclusive, 16×14×4in. 17 lb. † Multiple valve as Det. 2 L.F.
Radiocraft Supplies, Ltd., Arcade, Walsall.	"Peter Pan"	—	—	—	—	—	—	LG	Tr	P	—	—	D	B	—	6 15 0	Including batteries, valves a ndroyalties.
	Screened III.	—	—	—	—	SG	TT	LG	Tr	P	—	—	D	B	PP	12 10 0	,, ,, ,, ,,
Radio Gramophone Development Co., St. Peter's Place, Broad St., Birmingham.	Type D.C. G5 (*RG*)	—	—	—	—	—	—	—	—	—	—	—	—	DC	GP	75 0 0	Inclusive, Oak. 5 valve set with generous power output.
	,, D.C. D6 (*RG*)	—	—	—	—	—	—	—	—	—	—	—	—	DC	GP	75 0 0	,, ,, 6 ,, ,, ,, ,, ,, ,,
	,, D.C. D7 (*RG*)	—	—	—	—	—	—	—	—	—	—	—	—	DC	GP	125 0 0	,, ,, 7 ,, ,, ,, ,, ,, ,,
Radio Instruments, Ltd., 12, Hyde Street, London, W.C.1.	Transportable All Elec. 3 (*P*)	—	—	—	—	SG	TG	LG	Tr	P	—	—	Tr	DC	—	30 0 0	Including valves and royalties.
	,, ,, ,, (*P*)	—	—	*	—	*SG	TG	*LG	Tr	*T	—	—	Tr	AC	—	30 0 0	,, ,, ,, ,,
Read & Morris, Ltd., 81, Castle Street, London, W.1.	D.C. Simplicity Four	—	—	—	—	SG	TT	LG	Tr	T	Tr	T	F	DC	PP	32 0 0	Inclusive.
	Lone Star Overseas Four	—	—	—	—	SG	TT	LG	Tr	T	Tr	T	F	B or AC	PP	28 0 0 48 0 0	Battery model. Set and royalties only. Mains ,, inclusive.
Read Radio, Ltd., 32, Newman Street, London, W.1.	"Reaco" (*P*)	—	—	T	—	T	—	LG	—	T	—	T	Tr	B	—	13 13 0	Inclusive. Oak cabinet 11×16×8in. 22 lb.
Rees Mace Mfg. Co., 39A, Welbeck Street, London, W.1.	Gnome (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	—	19 19 0	Inclusive. Leather attaché case 13×11×6in. 20 lb.
	Twin Grand (*P*)	—	—	SG	TT	SG	TT	LG	Tr	T	Tr	T	D	B	PP	37 16 0	,, Mah. cabinet 20½×10½×8in. 42 lb.
,, ,, ,,	,, Baby (*P*)	—	—	SG	TT	SG	TT	LG	Tr	T	Tr	T	D	B	PP	35 14 0	,, ,, ,, 15×15×9in. 32 lb.
,, ,, ,,	Medium Four (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	PP	23 2 0	,, Leather attaché case 16×13×9in. 29 lb.
	Tourist Seven (*P*)	†	—	†	—	†	—	†	—	†	—	†	D	B	PP	40 19 0	,, ,, ,, ,, 17×14×9in. 35 lb. † 7-valve Super-Het.
Rialton Radio, 21A, Barbican, London, E.C.1.	Radiogramophone (*RG*)	SG	—	SG	—	SG	—	AB	Tr	T	—	—	Tr	B, AC or DC	GP	89 5 0 110 5 0	Battery model complete. Push pull output stage. Mains models ,, ,, ,, ,,
,, ,, ,,	"Melba" (*P*)	SG	—	SG	—	SG	—	LG	Tr	P	—	—	D	B, AC or DC	PP	From 42 0 0	Inclusive. Walnut, mah. or leather cabinet 17×18×10in. 40 lb.
,, ,, ,,	Screened Grid Portable (*P*)	—	—	SG	Ap	T	Ap	LG	Tr	P	—	—	D	B, AC or DC	PP	19 19 0	Inclusive. Battery model, oak, mah. or leatherette case, 15×12½×10in. 24 lb. Mains models £5 5s. extra.
,, ,, ,,	Junior Portable (*P*)	—	—	T	Ap	T	Ap	LG	Tr	P	—	—	D	B	—	16 16 0	Inclusive. Oak, mah. or leatherette case 14×12×9in. 20 lb.
Rolls-Caydon Sales, 77, Rochester Row, London, S.W.1.	Phantom Regional Screened 4 (*P*)	—	—	SG	Ap	SG	TA	LG	Tr	P	—	—	D	B	—	44 2 0	Inclusive.
,, ,, ,,	Portable Screened Four (*P*)	—	—	—	—	*SG	TA	*LG	—	*T	—	*T	D	AC	—	36 15 0	,,
,, ,, ,,	Radio-Gramophone (*RG*)	—	—	*SG	Ap	*SG	TA	*LG	Tr	P	—	—	F	AC	GP	75 12 0	,,
Rooke Bros., Ltd., 55, Cardington Street, London, N.W.1.	Faradex Five (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	PP	16 16 0	,, Leather case 15½×12½×8½in. 28 lb.
	,, S.G. Four (*P*)	—	—	—	—	SG	TG	LG	Tr	T	Tr	T	D	B	—	18 18 0	,, ,, ,, 17×13×10in. 32½ lb.
Royal Radio Co., 4/5, Dorset Mews North, London, N.W.1.	Five Valve (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	16 16 0	Inclusive. Fabrikoid suitcase 15½×12½×9in. 24 lb. Built-in wave trap.
,, ,, ,,	Screened Four Transportable (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	PP	19 19 0	Inclusive. 15×15×8in. 28 lb.
,, ,, ,,	Radio Gramophone (*RG*)	—	—	—	—	*SG	TT	*LG	Tr	*T	—	—	F	AC or DC	GP	50 8 0	,,
,, ,, ,,	Screened Four (*P*)	—	—	—	—	SG	TA	LG	RC	T	Tr	T	D	B	—	18 18 0	,, Leatherette suitcase 15½×12½×9in. 26 lb.
T. W. Rutter, 3, St. James' Road, West Croydon.	"Personic V." (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	16 16 0	,, Mah. cabinet 14½×8½×7in. 31 lb.
Saxon Radio Co., Henry Street Works, South Shore, Blackpool, Lancs.	Saxon S.G. Four	—	—	—	—	SG	TA	AB	RC	T	Tr	T	D	B	—	17 0 0 23 15 0	Including batteries, valves and royalties, stand model. ,, ,, L.S. and ,, pedestal ,,
,, ,, ,,	Saxon All Electric Three	—	—	—	—	—	—	*AB	RC	*T	Tr	*T	D	AC	—	18 7 6 25 17 6	,, valves and royalties, stand model. ,, ,, L.S. and ,, pedestal ,,
,, ,, ,,	Saxon 3-valve	—	—	—	—	—	—	LG	RC	T	Tr	T	D	B	—	From 6 10 0 From 14 10 0	Set and royalties only, stand model. ,, L.S. and ,, ,, pedestal ,,
James Scott & Co., Allscott Radio Works, Chapel Street, Dunfermline.	Allscott 4-valve (*P*)	—	—	—	—	SG	TG	LG	Ch	T	Tr	P	D	B	—	22 10 0	Inclusive suitcase 17×15½×10½in. 20 lb.
	,, VI.	—	—	SG	TG	SG	TG	LG	Ch	T	Tr	T	Tr	B, AC or DC	PP	49 10 0 37 10 0	Mains models, including valves and royalties. Push-pull output. Battery model ,, ,, ,, ,, ,,

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James Scott & Co., Allscott Radio Works, Chapel Street, Dunfermline—*continued.*	Allscott IV.	—	—	—	—	SG	TG	LG	Ch	T	Tr	T	D	B, AC or DC	PP	32 10 0 / 21 10 0	Mains models, including valves and royalties. Battery model " " " "
" " "	" III.	—	—	—	—	*SG	TG	*LG	Tr	P	—	—	F	AC and DC	PP	26 10 0	Including valves and royalties.
" " "	" III.	—	—	—	—	SG	TG	LG	Tr	P	—	—	D	B	PP	16 0 0	" " " "
" " "	" IIIB.	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	9 0 0	" " " "
" " "	" III. Radio-Gram. (*RG*)	—	—	—	—	SG	TG	LG	Tr	P	—	—	F	B, AC or DC	GP	37 0 0 / 50 0 0 / 39 10 0 / 52 10 0	" " " " Oak battery model. " " " " Mains models. " " " " Mah. battery model. " " " " Mains models.
" " "	" IV. Radio-Gram. (*RG*)	—	—	—	—	SG	TG	LG	Ch	T	Tr	T	F	B, AC or DC	GP	70 0 0 / 75 0 0	" " " " Oak. " " " " Mah.
" " "	" VI. Radio-Gram. (*RG*)	—	—	SG	TG	SG	TG	LG	Ch	T	Tr	T	Tr	AC or DC	GP	98 10 0 / 98 10 0	" " " " Oak. Output valves in push-pull. " " " " Mah. " "
Selectors, Ltd., 206/207, Bedford Avenue, Slough Trading Estate, Slough, Bucks.	Attaché Portable 4-valve (*P*).	—	—	—	—	SG	—	LG	Tr	T	Tr	T	D	B	PP	33 12 0	Leather attaché case 15½ × 13 × 8½in. 26 lb.
" " "	" Cabinet Four " (*P*)	—	—	—	—	SG	—	LG	Tr	T	Tr	T	D	B	PP	33 12 0	Mah. cabinet 17 × 15½ × 8in. 26 lb.
	" All Electric "	—	—	—	—	*SG	—	*LG	Tr	*T	Tr	*T	†	AC	PP	57 15 0	Including valves, L.S. and royalties. † Filter transformer.
	" Selector-Vox " (*RG*)	—	—	—	—	*SG	—	*LG	Tr	*T	Tr	*T	†	AC	GP	157 10 0	Inclusive. †Filter transformer. Output valves in parallel.
Sloan Electrical Co., Ltd., 8/12, Golden Lane, London, E.C.1.	" British Five " (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	13 15 0	Inclusive. Mah. cabinet 13¾ × 13½ × 8½in. 25 lb.
Stratton & Co., Ltd., Balmoral Works, Bromsgrove Street, Birmingham.	Eddystone Scientific Four S/W.	—	—	—	—	SG	TT	LG	Ch	T	Tr	T	D	B	PP	27 0 0	Including valves and royalties, 16-550 metres.
Symphony Gramophone & Radio Co., Ltd., 23/24, Warwick Street, London, W.1.	Radio-Gramophone de Luxe (*RG*).	—	—	—	—	*SG	TA	*AB	Tr	P	—	—	Tr	AC or DC	GP	115 0 0	Including valves and royalties. Push-pull output. With record compartments £10 extra.
	Radio-Gramophone (*RG*)	—	—	T	AP	T	Ap	LG	Tr	T	Tr	T	D	B, AC or DC	GP	From 37 16 0 to 47 5 0	Battery model inclusive. D.C. model £4 4s. 6d. extra. A.C. model £6 0s. extra.
" " "	Symphony Portable (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	Tr	T	D	B	—	17 17 6	Inclusive. Mah. cabinet 16 × 12¾ × 8½in. 30 lb.
W. W. Taylor, 20, Brook Street, London, E.C.4.	" Omnivox " 2-valve (*P*)	—	—	—	—	—	—	LG	Tr	T	—	—	D	B	—	8 0 0	Including batteries and valves. Mah. case 12 × 12 × 7in. 22 lb.
Tulsemere Mfg. Co., 1/7, Dalton Street, West Norwood, London, S.E.27.	" Tannoy " R-2	—	—	—	—	—	—	*LG	Tr	*T	—	—	D	AC	—	10 10 0	Complete. All Mains.
Tutills, Ltd., 7/9, Swan Street, Manchester.	" Tinol R.G." (*RG*)	—	—	—	—	SG	TG	LG	Tr	T	Tr	T	Tr	AC or DC	GP	65 0 0 / 55 0 0	A.C. model inclusive. D.C. " "
Ultra Electric, Ltd., 661/663, 843/845, Harrow Road, London, N.W.10.	Air-chrome S.G. IV. (*P*)	—	—	—	—	SG	TG	LG	Tr	T	Tr	T	D	B	—	21 0 0	Inclusive. Hide suitcase 13 × 13 × 7½in. 30 lb.
	" " V. (*P*)	—	—	T	Ap	T	Ap	LG	Tr	T	RC	T	D	B	—	16 16 0	" Rexine " 16 × 13 × 9in. 30 lb.
Universal Gramophone & Radio Co., Ltd., Ryland Road, Kentish Town, London, N.W.5.	" Truvox " Baby Grand (*RG*).	—	—	—	—	SG	TA	LG	Tr	T	—	—	D	B	GP	33 15 0	Inclusive. Oak.
	" Concert Grand (*RG*)	—	—	—	—	SG	TA	AB	RC	T	Tr	T	F	B	GP	51 0 0	" "
	" " " (*RG*)	—	—	—	—	*SG	TA	*AB	Tr	*T	—	—	F	AC or DC	GP	65 15 0	" "
Varley, 103, Kingsway, London, W.C.2.	Console Radio Gramophone (*RG*).	—	—	—	—	T	TG	LG	Tr	P	—	—	Tr	DC	GP	70 5 0	Including valves and royalties.
" " "	" " " (*RG*)	—	—	—	—	*SG	TG	*LG	Tr	*T	—	—	Tr	AC	GP	70 5 0	" " " "
" " "	Upright Radio Gramophone (*RG*).	—	—	—	—	—	—	LG	Tr	P	—	—	Tr	DC	GP	32 18 0	" " " "
" " "	" " " (*RG*)	—	—	—	—	—	—	*LG	Tr	*T	—	—	Tr	AC	GP	32 18 0	" " " "
" " "	All Electric Two	—	—	—	—	—	—	LG	Tr	P	—	—	Tr	AC or DC	PP	17 11 0	" " " "
" " "	" " Three	—	—	—	—	T	TG	LG	Tr	P	—	—	Tr	DC	PP	27 5 0	" " " "
" " "	" " "	—	—	—	—	*SG	TG	*LG	Tr	*T	—	—	Tr	AC	PP	27 5 0	" " " "
Watmel Wireless Co., Ltd., Imperia Works, High Street, Edgware, Middlesex.	Orthotone Imperial Radio-Gram (*RG*).	—	—	—	—	—	—	*LG	Tr	P	—	—	Tr	AC	GP	28 7 0	" " "
	" Imperial Two "	—	—	—	—	—	—	LG	Tr	P or T	—	—	D	B	PP	4 2 6	Set and royalties only.
" " "	" " Three "	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	PP	8 0 0	" " " "
" " "	Orthotone Radio-Gram (*RG*)	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	GP	26 5 0	Including batteries, valves and royalties.
Whittingham Smith & Co., Portadyne Works, Chase Estate, Park Royal, London, N.W.10.	Portadyne S.G. Four (*P*)	—	—	—	—	SG	TA	LG	Tr	T	Tr	T	D	B	—	23 2 0	Inclusive. Attaché case 14½ × 13½ × 10in. 30 lb.
	" Super Five (*P*)	—	—	T	Ap	T	RC	LG	RC	T	Tr	T	D	B	—	19 19 0	" Morocco attaché case 10½ × 15 × 14in. 28 lb
	" Table Grand (*P*)	—	—	T	Ap	T	RC	LG	Tr	T	Tr	T	D	B	—	26 5 0	" Oak or walnut cabinet 21½ × 11 × 15in. 32 lb.
Wholesale Wireless Co., 103, Farringdon Road, London, E.C.1.	Sensitite	—	—	—	—	—	—	AB	RC	T	Tr	T	F	AC	—	16 16 0	Including valves and royalties.
World's Wireless Stores, Grosvenor Road, Wallington.	Miracle Super Three	—	—	—	—	—	—	LG	Tr	T	Tr	T	D	B	—	9 18 0	Inclusive.

ABBREVIATIONS.—*RG* = Radio Gramophone. *P* = Portable. *Valves:* **SG** = Screen Grid. **TG** = Tuned Grid. **T** = Triode. **P** = Pentode. * = Directly or Indirectly Heated Mains Valves. *Coupling:* **TA** = Tuned Anode. **TG** = Tuned Grid. **TT** = Tuned Transformer. **Ap** = Aperiodic. **RC** = Resistance. **Tr** = Transformer. **Ch** = Choke. *Method of Rectification:* **AB** = Anode Bend. **LG** = Leaky Grid. *Loud Speaker Feed:* **D** = Direct. **F** = Filter. **Tr** = Transformer. *Current Supply:* **B** = Batteries. **AC** or **DC** = Mains Unit, Incorporated. *Gramophone Pick-up Arrangements:* **GP** = Pick-up included. **PP** = Provision for Pick-up.

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The Moving Coil Speaker and its Equivalent Circuit

The Relationship Between the Mechanical and Electrical Systems.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

THE coil-driven loud speaker is a mechanical device propelled by electric currents. It can be divided into two basic systems (1) a purely mechanical system, (2) a purely electrical system. The mechanical system causes sound to be radiated, whilst the electrical system supplies the energy necessary for this to be accomplished. By virtue of this relationship there is a definite connecting link between the mechanical and electrical systems. The object of this article is to indicate the interaction of the two systems and to give a diagram by means of which the combined performance can be visualised by aid of an equivalent electrical circuit.[1]

Taking the mechanical circuit, we have the arrangement of Fig. 1, which is equivalent to a mass *m* attached to a weak spring S, as shown in Fig. 2. The mass, whose effective value is *m*, corresponds to the diaphragm, whilst the spring corresponds to the diaphragm support. This is assumed to be elastic, and allows the diaphragm a fair amount of axial motion with but little constraint. Under this condition the natural axial frequency of the diaphragm (when the coil circuit is open) will be from 5 to 15 cycles per second. When the diaphragm vibrates there is a certain amount of resistance offered by the air, due to the generation of sound waves. Also, there is a loss in the diaphragm. These resistance effects impose a certain amount of damping on the mass *m*, i.e., it is not absolutely free to move with the spring.

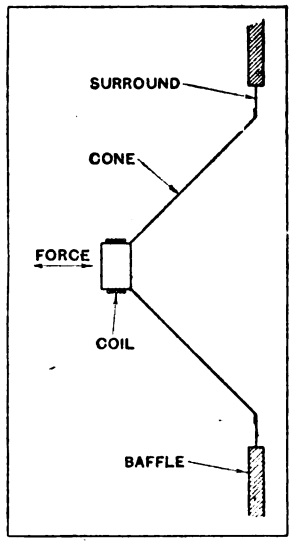

Fig. 1.—Diagram showing mechanical arrangement of coil and cone.

The electrical circuit is illustrated in Fig. 3. The coil is situated in a strong radial magnetic field. When the coil is fixed in position so that it cannot move, the electrical circuit is the simple form shown in Fig. 4, where the coil merely has an inductance L_o and resistance R_o commensurate with the number of turns and the effect of the iron of the magnet.

Now we have to combine the systems of Figs. 2 and 4. An alternating current will cause the coil to vibrate in the magnetic field. Since the coil cuts the field, an electromotive force is generated which tends to oppose the current in the coil. A small fraction of this e.m.f. is associated with the energy converted into sound. This will be evident from the following: The sound

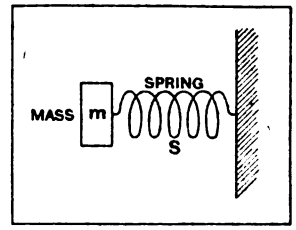

Fig. 2.—Simple mechanical equivalent diagram for arrangement of Fig. 1 assuming the cone to move as a whole.

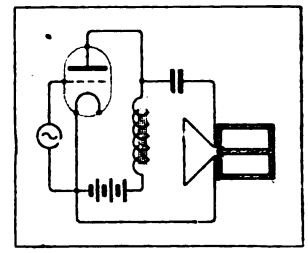

Fig. 3.—Diagrammatic arrangement of coil and power valve.

energy or power (whichever we like to consider) is derived primarily from the electrical circuit. Electrical power is the product of e.m.f. and in phase current. If, therefore, the coil current is *i* and the *corresponding* back e.m.f. (in phase with *i*) induced due to the motion of the coil is *e*, the power radiated as sound is *ei*. It should be observed that the current and e.m.f. are in phase, i.e., their maximum values occur simultaneously. This value *e* is one component of the back e.m.f., but there is another and a larger component which does no useful work. It merely reduces the value of the current at low frequencies, which is unfortunate.

If the coil were stationary there would be no induced back e.m.f., so that the simple arrangement of Fig. 4 does not represent the actual state of affairs. We have to incorporate in our electrical circuit something which accounts for the back e.m.f. The analysis leading to the final result is

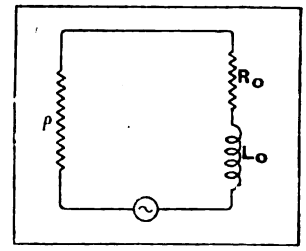

Fig. 4.—Showing equivalent valve circuit when coil is prevented from moving. The coil is represented by an induction L_o having resistance R_o. The internal A.C. resistance of the power valve is ρ.

[1] For complete theory see *Philosophical Magazine* Supplementary Number, June, 1929.

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The Moving-coil Speaker and its Equivalent Circuit.—

beyond the scope of this journal,[2] but we are not precluded from discussing the result. In Fig. 5 we have an electrical circuit[3] which behaves in the same manner as the moving coil of Fig. 4. Suppose we select a certain frequency, say 500 cycles, then by properly choosing C_m and R_m the current in the system will be identical with that through the moving coil at 500 cycles. R_m is the electrical resistance corresponding with the mechanical resistance to the motion of the diaphragm. The power loss in $R_m = i^2 R_m$, and this is the energy radiated as sound. The condenser C_m may appear extremely peculiar, but it is merely an electrical artifice which has the same effect in reducing the current at low frequencies as the back e.m.f. due to the motion of the coil.

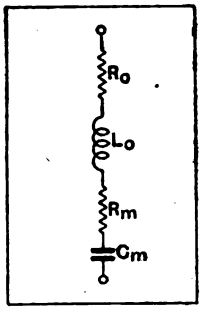

Fig. 5.—Equivalent circuit of moving-coil loud speaker when the diaphragm is in action. R_o is the acoustic radiation resistance. C_m is the motional capacity. Both R_m C_m are due to the back e.m.f. induced by the motion of the coil in the magnetic field.

Moreover, in Fig. 5 we have an electrical circuit in which the mechanical and electrical systems of the coil drive are represented. By its aid we can study exactly what will happen at various frequencies without considering the mechanical aspect of the problem at all.

There is a variation in the components R_m C_m according to the frequency, but we need not enter into such details here. The action of the coil in motion can also be represented by the equivalent circuit of Fig. 6. In this case the condenser C'_m and resistance R'_m are in parallel and have different values from R_m and C_m.

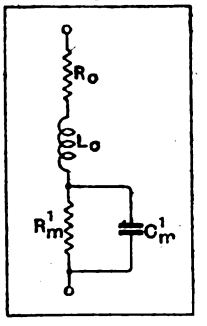

Fig. 6.

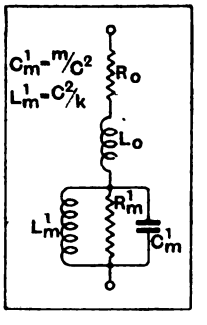

Fig. 8.

Fig. 6.—Alternative equivalent circuit of coil-drive loud speaker in action. R'_m and C'_m are now in parallel.

Fig. 8.—Circuit of coil-drive loud speaker, where the inductance, capacity and resistance equivalent to the motion of the coil are in parallel. L'_m does not vary with the frequency, until the diaphragm stops moving as a whole.

Hitherto we have considered cases where the frequency of the coil current is well removed from the natural frequency of the diaphragm on its support, viz., 15 cycles. When the frequency approaches 15 cycles it is clear that the amplitude of motion increases, due to mechanical resonance. This condition is not represented in Fig. 5, so that an additional electrical quantity is required to give the complete equivalent circuit.

In Fig. 5 it was essential to introduce a condenser C_m to represent the effect of the back e.m.f. due to the motion of the coil. We now have to represent the elastic effect of the surround, for C_m reduces the low-frequency currents, and therefore the axial movement of the diaphragm is also reduced. But the elasticity of the surround increases the amplitude of motion near 15 cycles, so that it gives the effect of an increase in current. Now we know that an inductance tends to neutralise the effect of a condenser. Moreover, we require an inductance to complete the equivalent electrical circuit for frequencies in the neighbourhood of 15 cycles. This has been added to Fig. 5, with the result exhibited in Fig. 7. Clearly the effect of the inductance L_m is to counteract the influence of the condenser C_m, so that the amplitude of motion is increased. Another method of representing the complete circuit is illustrated in Fig. 8. The inductance L'_m, capacity C'_m and motional or radiation resistance R'_m are now in parallel. The resonance frequency of the surround is identical with that of L'_m C'_m.

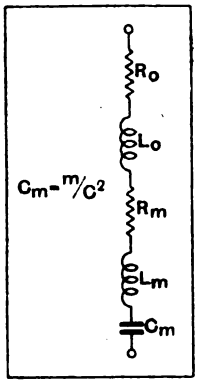

Fig. 7.—Equivalent circuit of coil-drive loud speaker in action at frequencies in the neighbourhood of the surround resonance. L_m is due to the elasticity of the surround and varies with the frequency.

The value of $C'_m = m/C^2$ where m is the effective mass of the diaphragm. This includes the added mass due to the sound waves caused by the motion. C is the product of the total length of wire on the coil and the strength of the radial field. $L'_m = \frac{C^2}{k}$ where k is the force required to move the diaphragm through an axial distance of 1 cm. against the supporting material.

In this discussion the diaphragm has been assumed to move as a whole at all frequencies. We know this does not hold in practice,[4] so that modifications will be required to cope with frequencies above about 200 cycles (depends upon size of diaphragm). These equivalent diagrams are extremely useful in studying the principle of the coil-driven loud speaker, since the complete outfit is reduced to an electrical circuit.

The values of L'_m, C'_m, R'_m, etc., will depend upon the size of the diaphragm, the mass of the coil, the number of turns on the coil, the strength of the magnetic field and the flexibility of the support. If the reader knows these factors for his own loud speaker he will be able to set down numerically its equivalent circuit. Of course, when resonances occur there will be a variation in the equivalent circuit. However, enough information has been given to introduce the subject to the reader who desires to have a deeper insight into the action of his loud speaker.

Incidentally, it is of interest to observe that Fig. 8 covers the case of a reed driving a rigid disc.

[2] See *Philosophical Magazine*, loc. cit.

[3] In Figs. 5 to 8 the equivalent circuit is shown with open ends. In practice, of course, the circuit is completed through something else. When transformer coupling is used, the secondary of the transformer is connected to the ends of the equivalent circuit. On the other hand, when a high-resistance coil is used, the circuit is completed through the valve and choke-condenser combination.

[4] See *The Wireless World*, July 10th and 17th, 1929.

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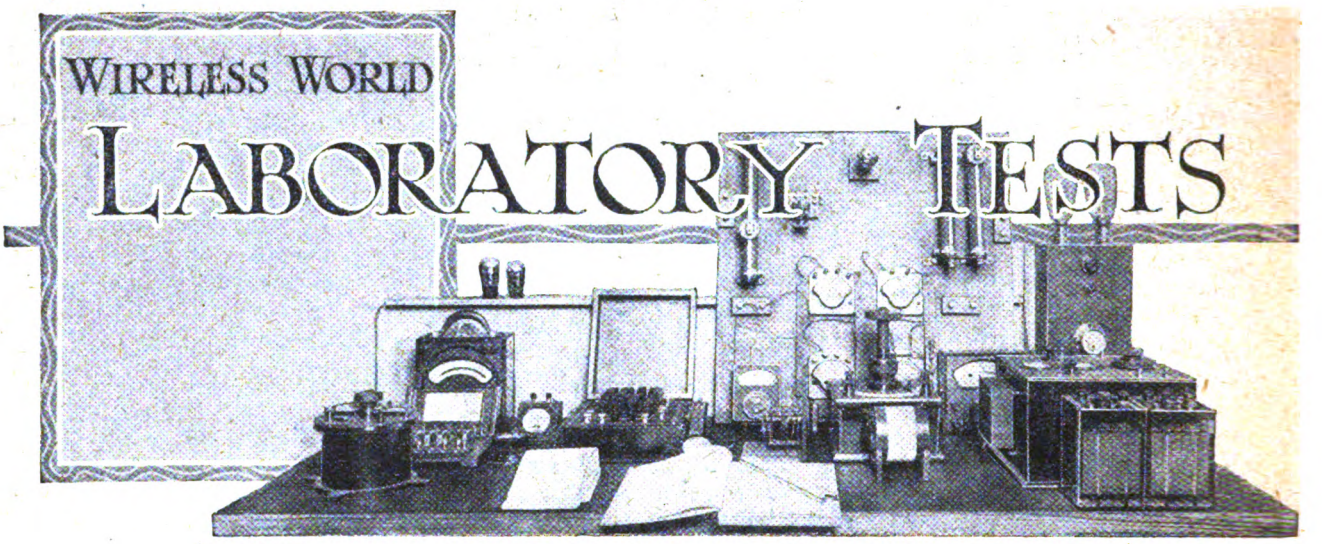
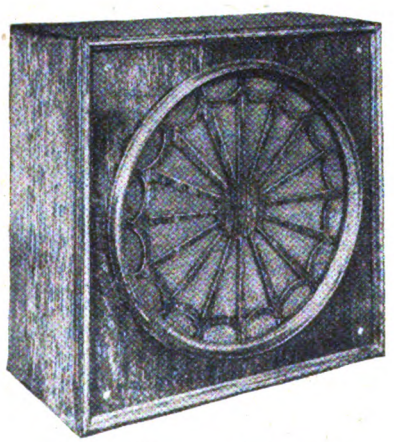


A Review of the Latest Products of the Manufacturers.

"ARBE" LOUD SPEAKER.

This is a cabinet cone instrument fitted in a case of generous size and pleasing finish. It is acoustically open at both back and front, a feature which attributes in measure to the good performance exhibited on test. The movement is an Ormond four-pole unit with adjustment, and this drives a 12in. cone.

Specially prepared material, somewhat resembling buckram in appearance, is used for the diaphragm. The periphery of the cone rests lightly against pads of felt; the driving mechanism being partially relieved of the cone's weight by holding this, at two points, by rubber clamps.



"Arbe" cabinet cone loud speaker.

A practical test, using a straight line amplifier, showed that over the major part of the audible scale the response was fairly even, but with a slight tailing-off at the higher frequencies. The middle register is well brought out, and the bass is in evidence but not unduly so, although the reluctance to bring out the treble in correct proportion gives the impression that the bass is emphasised unduly. However, this is an aural illusion not substantiated by test.

The instrument is sensitive to weak inputs and can be driven at ample volume for average-sized rooms with a medium-size power output valve. The D.C. resistance of the windings on the unit is 2,000 ohms.

This loud speaker is available in either an oak case or a mahogany cabinet; the prices being £3 10s. and £3 15s. respectively. The makers are The "Arbe" Radio Manufacturing Co., 25, Meredith Street, St. John's Street, London, E.C.1.

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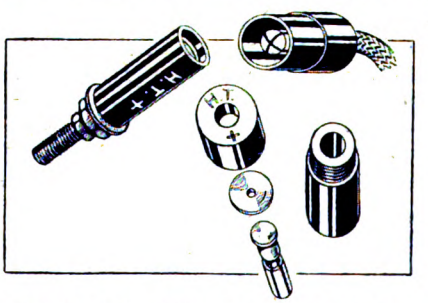
BELLING-LEE SAFETY CONNECTORS.

Messrs. Belling-Lee, Ltd., Queensway Works, Ponder's End, Middlesex, have for long specialised in the manufacture of insulated terminals particularly suitable for use where high anode potentials are employed. The latest addition to their wide range of connectors is a plug and socket having all "live" metal parts protruding from the panel adequately protected by insulating material.

The construction of these insulated H.T. plugs and sockets is shown clearly in the accompanying drawings. The socket is fixed to the panel, or terminal strip, and the completely insulated plug terminates the flex lead. Soldered connections are dispensed with and provision is made to grip the outer covering of braided silk, or cotton, thereby giving a tidy appearance to the leads. The price of the plug and socket is 9d., or they can be purchased separately, the panel portion costing 4d. and the flex connector 6d.



Details of the Belling-Lee insulated H.T. plug and socket.

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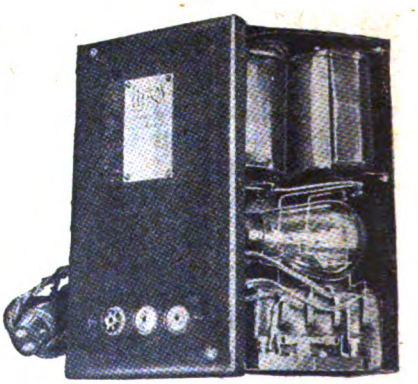
ELLISON H.T. ELIMINATOR.

This model has been designed for use on 200-volt 50-cycle supply mains, and gives two output voltages. That marked H.T.+1 is adjusted to suit the requirements of most detector valves, and H.T. +2 is intended to supply the remaining valves in the set. A series resistance



Ellison A.C. H.T. eliminator, Model P.1.

absorbs the excess voltage at the detector tapping, so that it is a simple matter to change this for one of different value, should this be necessary in any particular case.

Full-wave rectification is adopted, using a Marconi or Osram U.5 valve. At the time of test the mains voltage was 210, and this gave 5.5 volts across the valve's

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filament. This is slightly higher than the optimum voltage for this valve, but on a 200-volt supply it should prove about correct.

Each unit is accompanied by an instructional leaflet giving, in addition, a table of the voltages obtained under varying load conditions. These, together with the measured output voltages, are tabulated below.

H.T. + 2 Tapping.

Current in Milliamperes.	Makers' Voltages.	Measured Voltages.
5	200	215
10	182	195
15	170	175
20	150	159
25	135	142
30	120	127
35	107	115
40	85	106

The slight differences are accounted for, of course, by the higher mains voltage at the time of test.

The detector supply (H.T. + 1) is given as being measured with a load of 20 mA. on the H.T. + 2 supply. Reproducing these conditions we obtained the following voltage readings :—

H.T. + 1 Tapping.

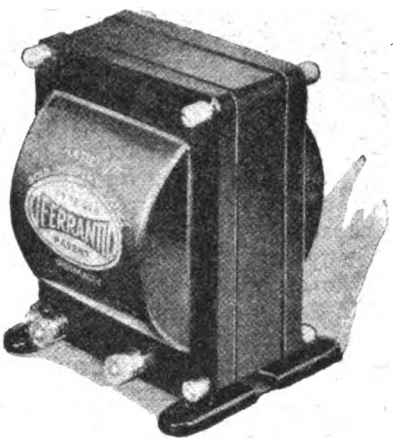
Current in Milliamperes.	Makers' Voltages.	Measured Voltages.
0.5	120	140
1.0	95	116
1.5	65	75
2.0	45	42

The unit was then given a practical test using a four-valve set (1-v-2). It was satisfactory in every respect; not the slightest trace of hum being noticed. We can confidently recommend this model.

The makers are the Ellison Manufacturing Co., Ltd., Dragon Works, Harrogate, and the price, including valve, is £6.

We have had samples sent to us for examination, and find that the coils comply with the specification given, and we believe they will be found satisfactory in every respect.

The workmanship is of a high order. Spacing of coils and sections are correct. A slight deviation has been made from the published description, this being the foreshortening of the spacers carrying the primary winding on the medium-wave H.F. transformer. Since this is a constructional detail of no particular importance, it will not affect the efficiency of the coils. We can confidently recommend them to all prospective constructors of this receiver.



Ferranti A.F.6 transformer. It has a step-up ratio of 1.7.

A NEW FERRANTI TRANSFORMER.

There is evidence to show that the present trend in design of receivers favours an increase in the number of H.F. amplifying stages with a reduction in the L.F. amplification.

Since most new designs show one low-frequency amplifier only after the detector, it is but natural that attention should be directed towards obtaining the maximum amplification from that stage.

Messrs. Ferranti have accordingly developed a special transformer—the A.F.6—with a ratio of 1 : 7. It has a slightly better characteristic than the A.F.3, when used with a suitable valve, and, of course, the amplification is very much greater. Needless to say, it should be preceded by a leaky-grid detector valve, as the primary impedance is hardly of sufficient magnitude to enable the best to be obtained with anode bend detection.

The amplification afforded by a combination of grid detector, A.F.6 transformer, and a super-power output valve, with a good mutual conductance, will compare favourably with that generally associated with a pentode output stage.

The makers are Messrs. Ferranti, Ltd., Hollinwood, Lancashire, and the price is 30s.

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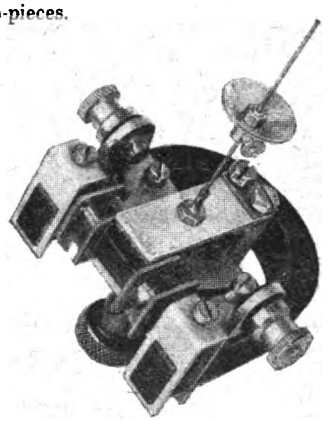
"STORK" LOUD SPEAKER UNIT.

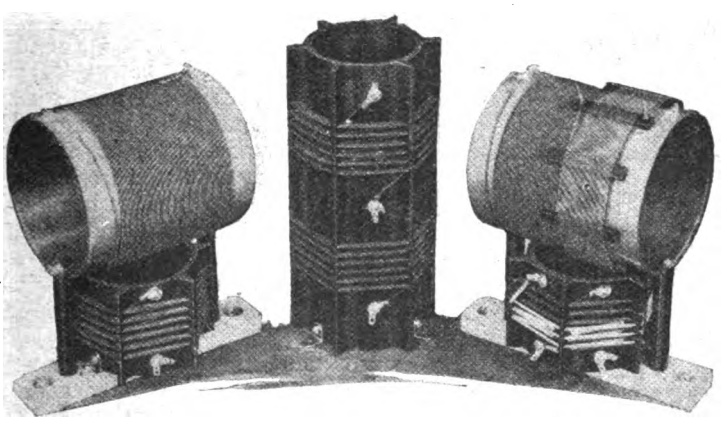
The "Stork" loud speaker unit is a product of the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2, and is the same movement as fitted to their cabinet loud speakers of the same name. It is now being offered as a separate unit for home construction at the attractive price of one guinea. It is for use with cone diaphragms. The movement is of the single-acting reed type, with the armature fixed at one end. An adjusting screw is fitted to regulate the clearance between the armature and the laminated pole-pieces.



G.E.C. "Stork" cone loud speaker unit. A single acting reed movement with adjustment.

A practical test was made, using a good cone diaphragm and a suitable baffle. On the whole the response was very good indeed; the frequency range, with normal electrical inputs, being from about 150 cycles to 5,000 cycles. There were sundry minor resonances—probably reed resonances, since this is fairly rigid—between 5,000 and 3,000 cycles, but these were not unduly marked. Otherwise the response was fairly constant over the audible band covered, but there was a noticeable tailing-off below 200 cycles.

The measured D.C. resistance of the windings was found to be 420 ohms. It is possible to connect the loud speaker direct in the H.T. supply lead to the last valve, even though a super-power type is fitted, without serious voltage drop. A choke-condenser filter, or transformer, output arrangement would be preferable, if this can be fitted conveniently.



Set of "Bercliff" coils for the 1930 Everyman Four receiver made by Simmonds Bros.

1930 EVERYMAN FOUR COILS.

Those constructors contemplating building the 1930 Everyman Four receiver may be interested to learn that a set of coils for this receiver has recently been placed on the market by Messrs. Simmonds Bros., Shireland Road Smethwick, Staffs. These are offered at 57s. the set.

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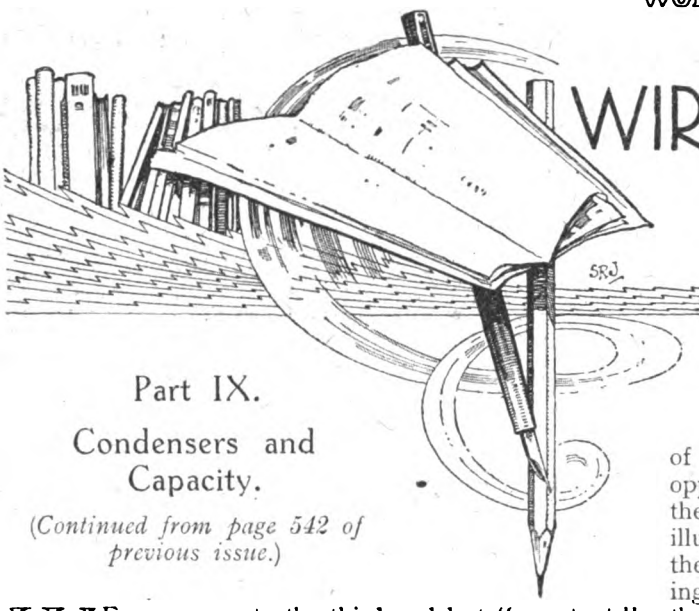

WIRELESS THEORY SIMPLIFIED

Part IX.

Condensers and Capacity.

(Continued from page 542 of previous issue.)

By S. O. PEARSON, B.Sc., A.M.I.E.E.

WE now come to the third and last "constant" of the electric circuit, namely, capacity. As the name implies, the capacity of any part of a circuit is the extent to which a "charge" or quantity of electricity can be stored or accumulated in that part. It is the capacity for storing electricity in a stationary (electrostatic) state under a given electrical pressure or voltage. In just the same way the capacity of a compressed-air cylinder could be expressed as the amount of air it would hold under a given pressure. That component of the electric circuit which is designed expressly for the purpose of producing this effect of capacity is called a condenser.

In order to understand clearly the effects of capacity, especially in an A.C. circuit, it is necessary to know exactly what capacity is and how it arises.

It was pointed out in Part I (September 25th issue) that a current of electricity could be looked upon as a stream of electrons passing from atom to atom along a conductor, the stream being continuous so that electrons were not accumulated at any point in the circuit. Under the heading of capacity, however, we encounter entirely new conditions, namely, where electrons are transferred from one part of a conducting system to some other part of the same system in which there is no complete or closed circuit for a continuous stream of electrons to flow round.

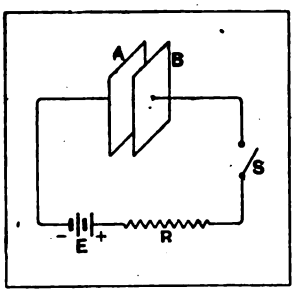

Fig. 1.—Simple parallel plate arrangement for illustrating the action of a battery and condenser.

Direction of Flow of Electrons.

But before proceeding farther a word is necessary regarding the direction of flow of electrons moving round a circuit carrying a current. It was explained in Part I that a free electron is a minute negatively charged "particle" which can be moved by the action of an electromotive force. The central positive charge of each atom of matter is not mobile in this way and cannot be separated from the atom of which it forms the nucleus. Thus a current of electricity is a stream of electrons moving in the opposite direction to that normally chosen to indicate the direction of flow of current. This fact is plainly illustrated by the action of an ordinary valve, where the current in the plate circuit is always taken as flowing from the positive terminal of the H.T. supply to the plate and thence through the vacuum to the filament. But we actually know that the electrons representing the current are given off or emitted by the hot filament and are collected by the plate and so move the other way round the circuit. In the early days of electricity, before the discovery of the electron, it was thought that both kinds of electricity moved round the circuit in opposite directions and the choice of the positive direction was quite an arbitrary one. In the light of the electron theory the choice has turned out to be very unfortunate, and the reader should bear in mind that when a current flowing through a circuit has its direction indicated by an arrow the actual direction of motion of the electrons representing that current is opposite to that indicated by the arrow. For most purposes this distinction is not necessary, but it is for our present purpose of considerable help in elucidating problems of capacity.

The Nature of Capacity.

Suppose that two flat metal plates A and B of equal size are placed parallel to each other, but not touching, as shown in the upper part of Fig. 1, and that they are electrically insulated from each other, the medium between them being air. Between A and B is connected a circuit consisting of a battery E, a resistance R and a switch S. In the figure the negative pole of the battery is shown connected to plate A.

Providing the switch S has not been closed no potential difference or voltage will exist between the plates (they could be momentarily joined together with a piece of wire to ensure this). This means that each plate carries an equal number of free electrons. If the plates are at zero potential with respect to earth the negative electrons on each are present in just sufficient numbers to neutralise completely the positive charges at the centres of the atoms and leave the plates as a whole electrically neutral. Now consider what happens

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Wireless Theory Simplified.—

when the switch S is suddenly closed. The battery will immediately try to drive a current round the circuit, but owing to the gap between the plates no continuous current will be able to flow. Nevertheless, the tendency is for the battery to drive electrons round the circuit in a clockwise direction, and so, on closing the switch, electrons will immediately be drawn off from plate B, passed through the battery, and piled up on plate A. As soon as any electrons are taken from plate B those left are insufficient to neutralise completely the positive charges at the centres of the atoms, and *so plate B acquires a positive potential.* The extra negative electrons which are driven on to plate A will give the latter a negative potential, as there will then be more than sufficient to neutralise the positive nuclei of the atoms.

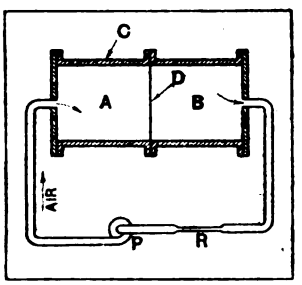

Fig. 2.—Air cylinder and fan pump system explaining in mechanical terms the action of a condenser. A diaphragm D divides the cylinder into two equal compartments A and B.

The initial rate at which the electrons are taken from B and put on to A by the action of the battery will depend on the E.M.F. of the battery and the resistance R of the circuit, because the stream of electrons flowing from B to A constitutes an electric current. But once this current has started the potential of B is becoming more positive and that of A more negative, that is to say, a potential difference is building up between A and B in such a direction as to oppose the action of the battery. Thus as time progresses, after closing the switch, the current, or rate of transfer of electrons, becomes rapidly less and ceases altogether when the potential difference between the plates has reached a value equal to the E.M.F. of the battery. Under these conditions plate A is charged exactly to the same potential as the negative pole of the battery, and B to that of the positive pole. We see, then, that the current obtained is only a momentary or transitory one which passes *from plate A to plate B* according to the usual notation although the electrons are moved from B to A.

An Analogy.

Before discussing the magnitude and time of duration of the charging current it will be helpful to consider a suitable mechanical analogy. The electric circuit of Fig. 1 can be represented by the cylinder and pipe arrangement shown in Fig. 2. An airtight cylinder C is divided into two equal compartments A and B by a diaphragm D. Compartment A is connected by means of a pipe to the output side of a fan pump P of the type used in ordinary vacuum cleaners, compartment B being connected to the input or vacuum side. The whole system is assumed to contain air at the normal atmospheric pressure when the pump is stationary, so that each compartment holds an equal weight of air, which corresponds to the electrons in the electric circuit. One of the pipes has a constriction R representing the resistance of the electric circuit.

If the fan pump is suddenly started it will immediately begin to draw air from compartment B and transfer it to A. The result is that the pressure in B begins to fall and that in A to rise, just as in the electric circuit the potential or electrical pressures of the plates were changed. In the same way the current of air through the pipe diminishes as the pressure difference between compartments A and B rises and will cease altogether when the difference of pressures in the two compartments is exactly equal to the pressure exerted by the pump. A continuous stream of air cannot flow on account of the dividing diaphragm in the cylinder corresponding to the gap between the plates of the electric circuit.

As regards the air system it is quite obvious that energy is required to change the pressure levels of the compartments of the cylinder as described, and that energy is stored in the cylinder. If the motor driving the pump is switched off the air will immediately commence to rush back from A to B and so tend to drive the fan in the reverse direction. The amount of energy stored will depend on the capacity of the cylinder and the difference in pressure between the two compartments.

Electric Field.

Now, in exactly the same way, energy must be stored somewhere in the electric circuit of Fig. 1 when the electrical pressure between the plates A and B is raised, because during the time that the plates are being charged the battery is driving a current against an opposing pressure quite apart from that due to the resistance of the circuit. This energy is stored in the space between the plates. The ether there has been subjected to a sort of strain and is trying to recover—it makes practically no difference whether there is air or a vacuum between the plates.

The space where the ether is strained in this way is called an electric or electrostatic field, and its presence can be very easily detected experimentally. If a small light body such as a pith ball, suspended on a silk thread, is charged positively and then dangled between the plates it is definitely attracted towards the negative plate A and repelled from the positive plate B, showing that there are lines of force stretching from one plate to the other. These lines of force are quite different from those of magnetism; they are produced by electrons at rest, whereas the magnetic lines were produced by electrons in motion, that is, by an electric current.

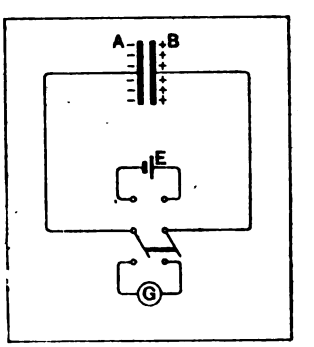

Fig. 3.—Circuit for charging a condenser and then discharging it through a galvanometer.

The electrostatic strain set up in the ether by the charges on A and B is a sort of elastic one tending to return the potentials of the plates to their original common level. If we disconnect the plates from the

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Wireless Theory Simplified.—

battery and then join them to the terminals of a sensitive galvanometer the latter will give a momentary deflection indicating that the excess negative electrons on plate A have rushed back and made good the deficiency on B. Our simple condenser has been discharged and the energy which it possessed dissipated in the resistance of the circuit connecting A to B. The switching arrangement for the experiment is shown in Fig. 3.

Definition of Capacity.

When the switch is closed the initial value of the charging current will be $I=\frac{E}{R}$ amperes, because at the start there is no back pressure exerted by the condenser. But as the voltage across the condenser builds up it

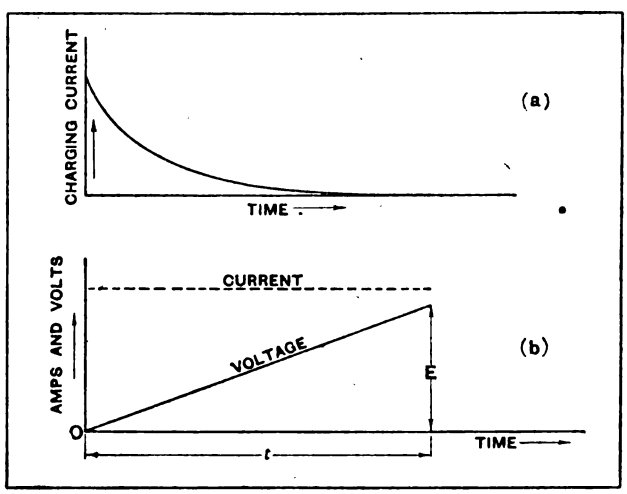

Fig. 4.—(a) Curves showing how the charging current dies away under normal conditions. (b) Conditions existing when the charging current is controlled and kept constant. The voltage across the condenser rises at a uniform rate.

opposes more and more the action of the battery, and so the value of the charging current diminishes as time progresses. If e is the voltage across the condenser at any instant the current at that instant will be $i=\frac{E-e}{R}$ amperes, and so the charging current will die away according to a definite law. The current would actually die away in the manner indicated by the curve of Fig. 4 (*a*). However, it would help us to give a simple definition of the capacity if we could arrange to maintain the charging current *constant* at the initial value throughout the charging period. This could be done theoretically by reducing the variable resistance R in Fig. 3 at a uniform rate from the initial value to zero during the charging period. Under these conditions the voltage across the condenser would rise at a uniform rate, as shown in Fig. 4 (*b*).

Suppose, then, that with a steady charging current of I amperes the potential difference between the condenser plates reaches a value of E volts in a time of t seconds. Now, the product of the current I and the time t is the *quantity of electricity* transferred from one plate of the condenser to the other. From this *the capacity can be defined as the quantity of electricity or "charge" required to change the potential difference between the plates by one unit of E.M.F.*

Practical Units of Capacity.

When the charging current I is in amperes and t is in seconds the quantity of electricity or "charge" is expressed in *coulombs*. The capacity in the practical system of units is expressed in *farads*. A condenser is said to have a capacity of one farad if the potential difference between the plates is raised by one volt when a quantity of electricity equal to one coulomb is put into it, or when a charging current of one ampere flowing for one second changes the potential difference between the plates by one volt.

Thus if a current of I amperes flowing for t seconds raises the potential difference between the plates from zero to E volts the capacity of the condenser will be

$$C=\frac{It}{E}=\frac{Q}{E} \text{ farads}$$

where Q stands for the charge in coulombs or ampere-seconds.

The farad is a very large unit indeed. If a condenser of one farad capacity were charged to one volt, on being discharged through a resistance it would give out one ampere for one second or the equivalent. If charged to 180 volts it would be capable of giving out the equivalent of one ampere for three minutes! It would require an enormous condenser to give such a performance. Thus in general practice the capacity of a condenser is expressed in *microfarads* (mfd.), meaning millionths of a farad. But when making calculations relating to condensers farads must be used in all the ordinary formulæ; to convert from microfarads to farads we must divide by 10^6 or one million. Very often in wireless work capacities are expressed in *micro-microfarads* (m.mfd. or $\mu\mu$f) or millionths of a microfarad.

(*To be continued.*)

CATALOGUES RECEIVED.

The Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4.—Descriptive folder of Screened Grid Short-Wave Receiver; a four-valve set covering wavelengths from 10 to 85 metres and employing H.F. amplification.

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The Lisenin Wireless Company, 5, Central Buildings, High Street, Slough, Bucks.—Illustrated folder of Wander plugs, spade terminals and insulated mains connectors.

The Edison Swan Electric Co., Ltd., 123-5, Queen Victoria Street, London, E.C.4.—Illustrated catalogues of Ediswan mains- and battery-operated receivers; mains accessories; components, and a 58-page valve book containing curves and descriptive matter dealing with every new Mazda valve. Also general radio catalogue and descriptive folders of "Tungar" battery chargers.

o o o o

Messrs. Ferranti, Ltd., Hollinwood, Lancashire.—Descriptive catalogues of A.C. and D.C. measuring instruments, push-pull transformers, anode feed units, and illustrated leaflets dealing with motor car battery charger and radio switches. Descriptive folder of moving-coil loud speakers.

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BROADCAST BREVITIES

By Our Special Correspondent.

New Wavelength for 2LO ?—Scottish Regional Sites.—Test Relays from Germany.

A Dilemma.

B.B.C. engineers are in a dilemma regarding the opening of the second station at Brookmans Park. For a reason which remains obscure, there is an insistent demand in some quarters that the regular London programme, *i.e.*, 2LO's, should go out on the shorter wavelength of 261 metres, allowing the hitherto silent twin to carry out its tests on 356.3 metres.

oooo

To Wake Up the Public?

This would be the best way to proceed if the B.B.C.'s intention is to wake up the public to the realities of the regional scheme, especially in view of the likelihood that the tests with the new transmitter will be limited to news, talks, and poetry readings! In the scramble for new coils and condensers the listening public would begin to see the scheme from a fresh angle.

oooo

Nervousness.

This hesitancy in regard to wavelength is symptomatic of a growing nervousness at Savoy Hill over the behaviour of twin stations on the same site. The B.B.C.'s experience in this direction is mainly theoretical, being based on low-power radiation tests with the mobile transmitter. The case of 5XX and 5GB working on the same site can hardly be called a parallel one, for here the frequency separation is 433 kC., whereas the London Regional transmitters will have a separation of little more than 300 kC. with higher power also to be reckoned with.

oooo

Protracted Test Period.

As to the date on which the alternative tests will start, even the Chief Engineer expresses uncertainty. It is practically settled, however, that the experiments will take place during ordinary broadcasting hours over a period of at least two months. Assuming that the fun begins before the end of December, we shall have the season of spring and portable sets upon us before London Regional is functioning normally.

oooo

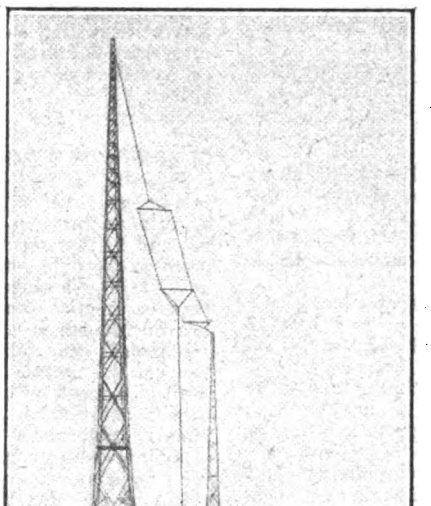
Scottish Regional Excitement.

Captain Eckersley has caused a flutter in official dovecotes by a statement in a speech at Edinburgh last week. The ex-Chief indicated that a site has already been selected for the Scottish Regional station at Larbert, midway between Glasgow and Edinburgh. As a matter of fact, no decision has yet been arrived at. The B.B.C. mobile transmitter has roamed over most of the country in the neighbourhood mentioned, and three possible sites are now being considered. Larbert is one of them, but the most favoured is a spot to the east of Falkirk.

oooo

A Question of Money.

It will be a pity if announcements regarding the Scottish Regional raise false hopes. Many listeners in Scotland have been expecting that their new station would be ready by the end of 1930. If the work were begun at once there would be no technical bar to such a happy event, but there are grave financial obstacles. The Northern Regional must be paid for this year, and the B.B.C. will require more instalments of licence revenue from the Post Office before the Scottish Regional can be completed.



A FAMOUS DEUTSCHLANDER. The Langenberg transmitter photographed from an unusual angle. With the aid of its relays, Langenberg serves nearly all Western Germany. It also succeeds in heterodyning 5GB!

oooo

Relays from Germany.

Three experimental relays from the Continent are to be included in the programmes early in the New Year. The first, I understand, will take place on or about January 3rd, when Germany's new cross-country landlines will be put to the test in a relay from one of the eastern transmitters, probably Königswusterhausen.

The programme value of these relays will also be considered. The first will comprise classical music; German light music and vaudeville will be featured in the other relays.

oooo

Suffocation in the Studio.

Few broadcast artists deserve to be suffocated in the studio. Yet this fate nearly overtook a well-known performer at Savoy Hill recently when he strayed too near a ventilating tube which had been cleaned with paraffin. He is only just recovering from an illness which has lasted for weeks.

The problem of studio ventilation will be one of the first considerations of the designers of Broadcasting House, Portland Place. Entirely new methods are to be tried, as it is realised that the present system at Savoy Hill is hopelessly inadequate.

oooo

Au Revoir, Sir Walford.

All classes of listeners—highbrow, lowbrow, technical, constructional, and the rest—will miss the weekly talks of Sir Walford Davies. There is something arresting in Sir Walford's microphone manner which compels one to listen, whether interested in music or not. Most of us will be glad that the well-known "Good-night, listeners all!" on December 31st will be only in the nature of an *au revoir*.

oooo

Cinema Assists Broadcast Artists.

Anthony Hope's play, "The Prisoner of Zenda," will be broadcast from 2LO on December 20th. The adaptation for the microphone is the work of Holt Marvell, who has conceived the idea of arranging a special show of Rex Ingram's film version for the artists who are to take part in the broadcast to enable them to "absorb" the atmosphere of the story.

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CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

ANODE FEED.

Sir,—Much print has been used in the last year or so in an effort to popularise the "anode feed" scheme. Admittedly it has great advantages over the "common" potentiometer, and it has enabled "Mr. Everyman" to use modern valves to a fairly good advantage, but in my opinion better advantages are to be gained by using a potentiometer for each valve. The cost of wire-wound potentiometers, such as Truevolt and Varley type, is little over that of fixed resistances, and among the advantages of this scheme are :—

(1) Voltage more constant in spite of anode current fluctuations.

(2) Change of valve involves a simple adjustment instead of the purchase of a new anode resistance.

(3) In the case of A.C. H.T. eliminators the small but constant load on the transformer secondary safeguards the components from harm should the valve filaments be unlighted from any cause while the elimination is under load.

I have used this scheme in several cases when "motor boating" has occurred, in spite of the anode feed scheme, with complete success.

I would be interested to know of other readers' opinions on this scheme. A. NEWMAN.

THE REGIONAL SCHEME.

Sir,—Re your editorial and correspondents' comments on the regional scheme.

I, too, have thought the B.B.C.'s policy may have, in part, provided for "wipe-out," so as to limit stations received to those at home; but surely, to be effective, there must be a full and adequate programme provided by them!

At present my sixty-one stations have been reduced to fifty-nine, and should Tweedledee cause a further reduction no more serious and the B.B.C. not extend its Sunday programme, I will continue my naughtiness in tuning in gay foreigners—particularly on Sundays.

I remove headgear to Iliffe and Sons Ltd., the gay foreigners and the frame aerial. HENRY J. BELL.

Wendover, Bucks.

NON-RADIATING SETS.

Sir,—May I add my name to that of Mr. Henry W. Moss? Re-radiation from other receiving aerials is the biggest trouble I have to contend with from a wireless point of view. A man may not go about the streets interfering with the business or pleasure of other people, and neither should he be allowed to do it by radio.

I use a moving-coil loud speaker capable of excellent reproduction, but if there is anything on worth hearing I have to switch off in disgust at the distortion introduced by "silent point" oscillators and the howls of the actual heterodyners. I heartily agree that the use of reacting detector, or any other set capable of energising the aerial should be made illegal. Administration of the law would not entail great expense, as complaints alone would be sufficient indication of offenders.

If the business was sufficiently stressed in journals, members and officials of radio societies and readers of technical magazines could get together and probably demand it. Also, why not go a step in the right direction and stop set designers and radio manufacturers from the practice of publishing diagrams of cheap (?) receivers capable of re-radiation. I am aware some cheap outfits for local stations only are always in demand, but one generally finds the owners trying to get America at full L.S. strength. Let us hear more views and get the whole miserable business stopped once and for all. JOHN ROE.

Sheffield.

Sir,—I have a great deal of sympathy with your correspondent, Mr. Henry W. Moss, being like him a sufferer from the howls emanating from my neighbour's set next door.

I think something should be done to curtail the activities of the oscillating individual: at present the measures taken by the Post Office are not drastic enough. If reaction was prohibited entirely I am afraid many worthy people in humble circumstances would be tied down to the local B.B.C. programme owing to the high prices at present prevailing for screen grid receivers. I am convinced from my own experience that reaction, if properly used, should cause practically no interference to neighbouring receivers. It is the selfish person who wants more service from his small receiver than it is capable of giving, and I hope steps will be taken before long to put a stop to this great nuisance. HUGH McNEICE.

London, S.E.6.

Sir,—I have read with interest Mr. H. W. Moss's letter in your issue of the 6th inst. on the subject of radiating receivers.

I do not agree with Mr. Moss's view that the advent of the screen-grid valve has sufficiently altered the position to justify legislation to prohibit the use of receivers capable of energising the aerial.

The most popular type of set at present in use in this country appears to be the straight three-valver, which depends on the critical adjustment of reaction for its sensitivity and, in some measure, its selectivity.

I quite agree that the universal adoption of the screen-grid valve would solve the problem of oscillation very satisfactorily, but a great number of the sets at present in use could not be modified to include a screen-grid valve with its attendant elaborate screening.

It would mean that a large percentage of people now obtaining satisfactory reception on a straight three-valver would either have to do away with the reaction that is so essential to them, or, alternatively, modify their receivers at considerable cost.

I have been using a four-valver incorporating one screen-grid valve, anode-bend detector without reaction, and two R.C.C. stages of low-frequency amplification, for about a year, and this gives me all I need in selectivity, volume, and sensitivity, but its cost is in no way comparable with that of a straight three-valver. HARRY W. DALY.

Goodmayes, Essex.

GRAMOPHONE PICK-UP DESIGN.

Sir,—Mr. F. L. Devereux, in dealing with the above subject in a recent issue of *The Wireless World*, mentions that serious amplitude distortion is caused by a single-acting type of pick-up, and further mentions that the single-acting type has given place to the differential or double-acting type.

While this is obviously theoretically correct, the fact remains that in practice the amplitude distortion (due to the square law mentioned) is of no importance when compared with the mechanical controlling factors, such as mass of the reed, moment of inertia, restoring force, etc., which of course were also mentioned in the article.

It is not difficult to find amongst commercial pick-ups differential types with a response curve definitely inferior to that of a single-acting type. I believe I am correct in stating that the new Marconiphone pick-up employs a reed in which the whole of the flux passes through it, and the curve of this pick-up is unquestionably good. The same principle would seem to be involved in the case of a loud speaker movement, when mention can be made of the Amplion Lion speaker. Here again the performance is definitely superior to that of many balanced armature systems. The predominating factors in both cases are mechanical rather than electrical. If the same desirable mechanical conditions were combined with a balanced electrical or rather magnetic, system, then the results might possibly be even slightly better. My own experience in the design of pick-ups during the last three years clearly indicates that the predominating controlling factors are mechanical rather than magnetic, and this certainly seems to be borne out by the examples mentioned above. PAUL D. TYERS.

Watford.

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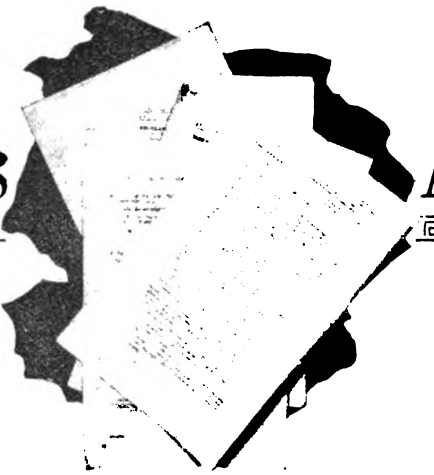
Supply Regulations and Mains Sets



The Mutual Obligations of Set User and Supply Company Explained.

IT would probably not be far wrong to assume that daily close upon one hundred wireless receivers are connected to public electricity supply mains for the first time. Some of these sets have been designed and built expressly to operate either partially or wholly from mains, while others have been converted from battery-driven receivers by the addition of various parts collectively called an eliminator or mains unit. In both these classes there is a further sub-division of "bought," *i.e.*, completely finished, equipments and "home-built" or "home-made" apparatus in which the various parts have been collected together and assembled by an amateur.

There is every reason to believe that, with the improving discernment in the matter of quality of reproduction on the part of the general public, at no distant date practically all stationary receivers will be mains operated, so that a few notes on the legality of the use of public mains will not be out of place.

Board of Trade Regulations.

To begin with, let us consider how supply authorities are regulated. Before a company or a borough council may proceed to excavate the public roads for the purpose of laying mains, it has to obtain parliamentary powers. The granting of such powers virtually gives a company a monopoly within a prescribed area, and in order to prevent the abuse of such a monopoly the company is governed by certain Acts, notably the Electric Lighting Acts of 1882 and 1899, and a set of Board of Trade Regulations. In general, the Regulations are of more interest to the consumer than the Acts. The concern to which powers have been granted is referred to in the Acts as an Undertaker.

The Board of Trade Regulations (now called the Regulations of the Electricity Commissioners) are expressly headed as being:—

(*a*) For securing the safety of the public, and

(*b*) For ensuring a proper and sufficient supply of electrical energy.

They are obtainable on demand at the price of sixpence per copy by a consumer from the Undertaker in whose area of supply he resides, and are the only legal Regulations governing that supply. They may also be obtained with certain blanks left in the final clause, which makes them specific to an undertaking, from H.M. Stationery Office.

Now to deal with the Acts and Regulations as they affect the consumer who wishes to use power from the mains to operate his wireless receiver. Although it can be assumed that anyone who is contemplating the use of supply mains to drive his wireless set has already a supply (and a supply company is bound by section 27 (i) of the 1899 Act to give and maintain a supply subject to certain conditions), it must be assumed that the addition of a mains-driven wireless set to his power-consuming appliances is such a serious matter in the eyes of the supply company as to warrant reconsideration of the original agreement for the supply of electricity to that particular premises.

The only technical condition under which a company may refuse supply to a consumer is when there is found to be a leakage of more than 1/10,000th part of the maximum supply current on his (the consumer's) wiring and apparatus, and in so refusing the company is bound, under penalty, to call attention to the consumer that he may, if he doubts its tests, on payment of a fee, have the tests carried out by a Board of Trade inspector. This is covered by Regulations 29, 30, and 31.

D.C. Mains and Condenser Tests.

Sections 27 (4) of the 1899 Act refers to the use of any lamp or burner (electric motors were not even legislated for in those days) in a manner calculated to interfere unduly or improperly with the efficient supply to any other body or person as a good and sufficient reason for the refusal on the part of the company to supply. In view of the contacts or fuses mentioned in Regulation 26 and the leakage specification in Regulation 29 of the Board of Trade, the foregoing clause does not appear to have any very specific meaning. A possible case coming under this clause might occur if a consumer installed a piece of apparatus which took a very heavy momentary current, say, once every second, the current being just of insufficient duration to blow his main fuses, but sufficient to cause an unpleasant flicker in the illumination of the lamps on neighbouring premises. This state of affairs is not likely to occur in a wireless receiver.

With regard to the current leakage referred to above, this can be prevented with certainty in an A.C. set operating off A.C. mains by the use of a transformer with adequate

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Supply Regulations and Mains Sets.—insulation between the primary and all other windings, and in a D.C. set by the use of a good condenser in the earth lead, together with a further condenser in the aerial lead if series tuning is not being used and the aerial insulation is not above suspicion. The recognised standard test for the insulation value of first-class British-made apparatus intended to be used on supply mains is the application of 2,000 R.M.S volts A.C. of commercial frequency, *e.g.*, 50 cycles for one minute between conductor and earth. This test is not really as severe as it sounds, and there should be no difficulty in insulating transformer primary windings to pass it when all other windings are earthed; in fact, there are certain intervalve transformers whose insulation is sufficiently good to withstand this voltage. There must, however, be very few condensers at present in earth leads which are able to pass this test, and in view of the size and cost of a condenser of this grade it is doubtful whether a company could be considered as reasonable in demanding compliance in this respect.

Protection from Shock.

The Regulations, beyond stipulating the maximum permissible leakage on a consumer's system, do not mention insulation value. As regards its own network, the company is only bound to test a new low or medium pressure (*i.e.*, voltage) main at its working pressure, or not less than 200 volts before being put into service. Even on high-pressure work the company is only called upon to test at 50 per cent. over working voltage for one hour. The corresponding up-to-date test in the British industry is 2¼ times working voltage, plus 2,000 for one minute, and certain manufacturers test at three times working voltage for this time.

There remains a further direction in which legislation might be expected, namely, in the protection from shock. Now it is one of the rather remarkable facts that in the matter of Regulations dealing with installation work, an Englishman's home has remained his castle for such a long time. The Institution of Electrical Engineers has prepared an excellent set of wiring Regulations which are revised from time to time to keep up with modern developments and the introduction of new and better materials. Quite recently much work has been done to produce a specification covering the essential points in eliminator design, but although these Regulations may be referred to by consulting engineers, buyers, insurance companies, etc., as indicating a certain standard of excellence, they do not appear to have any legal significance as far as the house is concerned. On the other hand, an insurance company, say, might refuse to accept as a fire risk a building in which the electrical installation fell below the standard set by the I.E.E. Regulations.

What are the regulations governing the connecting of a wireless receiver to the mains? The endeavour in this article has been to make clear the position of both the user of the mains operated set and the electricity supply company and to outline the restrictions and obligations imposed.

To sum up this section of the article, there seems to be no valid ground on which supply may be refused to a mains receiver which does not actually produce a leakage to earth from either mains greater than the prescribed amount.

We come now to the question as to where the owner of a mains-driven wireless set stands when it is decided to change over the mains from D.C. to A.C., and it is unfortunate that at present the legal position is still obscure. From enquiries made, it is understood that the matter will eventually be fought out by means of a test case.

Much consternation was created in the electricity supply world by a letter which appeared in the correspondence columns of this journal some years ago now, in which a resident in one of the towns on the Northern outskirts of London expressed satisfaction at the treatment received from the supply company, who provided him with a complete A.C. eliminator (possibly then worth ten pounds) when they converted their network in that particular area from D.C. to A.C.

Most supply authorities who have had to face a change-over have accepted the moral obligation to render sets connected to their mains suitable for the new supply, but the method adopted has had to vary with individual sets. The obligation is generally considered to consist of leaving the control of the set unchanged.

Variation in Supply Voltage.

In some cases, only an H.T. eliminator is supplied, or possibly a metal rectifier for battery charging. In general, no difference is made between home-built and professionally built sets, but the new H.T. eliminator will probably only supply semi-smoothed current, reliance being placed on the smoothing apparatus of the original D.C. arrangement to complete the process. This seems quite reasonable, and it must be remembered that this modern development of mains-driven wireless receivers presents a very difficult and costly problem to supply authorities whose area happens to be mainly residential.

Before completing this article, mention should be made of a direction in which a number of supply authorities fail badly. This is in the matter of pressure at the consumer's terminals. By Board of Trade Regulation, the total permissible variation in supply voltage at the consumer's terminal is 4 per cent. up or down, but it is within the writer's experience to have his mains voltage vary by as much as 12 per cent. down on a cold winter evening, and 10 per cent. up on a bright Sunday morning.

Such a wide variation, which, of course, affects the filament brilliancy of the rectifying valves in the mains units, as well as their anode supply volts, and, therefore, produces somewhat of a square law effect, can be the cause of much trouble in a high-class receiver.

There are two remedies, first, to use a transformer with a tapped primary, which will allow for compensation to be made by means of a multi-way switch, and, secondly, to complain to the supply company, who cannot ignore such matters.

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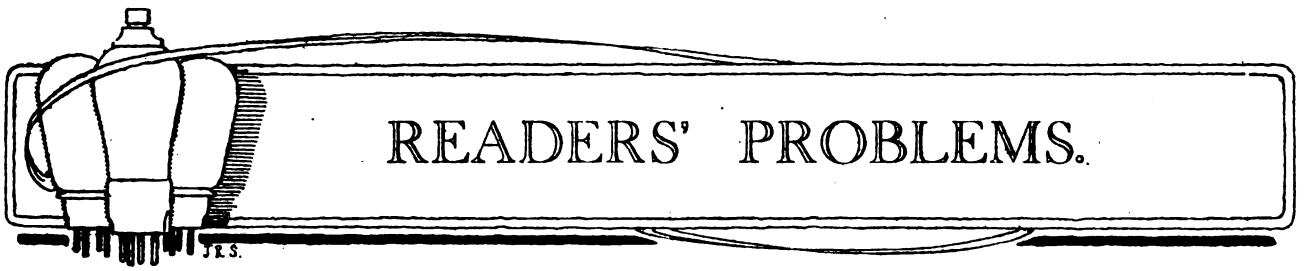

READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Plug-in Coils for the Aerial Circuit.

I am making up a receiver on the general lines of "The Wireless World" Kit Set. Will you please tell me if there is any reason why ordinary plug-in coils should not be used for aerial circuit tuning? C. W. N.

Commercial plug-in coils can certainly be used in the open circuit, although there would hardly be room for them in a set having the same layout as that described and illustrated. The coils should be mounted with a reasonable spacing between them, and if they are placed coaxially in inductive relationship interconnection should be such that one winding forms a continuation of the other.

o o o o

Mains Safety Precautions.

I am told that a set operated from the mains should not be directly earthed in the usual manner, and in consequence am surprised to find that there is a metallic connection between the aerial and earth terminals of my new receiver. Would you recommend the fitting of an external earth condenser as a safety precaution? E. F. E.

This depends on whether your supply is A.C. or D.C. If the former, it may be stated definitely that no series condenser is necessary, as the set will be effectively isolated from the mains by a double-wound transformer. We expect that your mains are of this type, but if you have a D.C. supply, the condenser should be added, unless the aerial-grid transformer has separate windings. If it has, and if the insulation between these windings is adequate, the set will be quite safe, in spite of the fact that a test will show continuity between aerial and earth terminals.

o o o o

Needle Scratch.

I have recently converted my set for gramophone reproduction, and notice that there is excessive needle scratch. This is not due to the pick-up itself, as the same instrument functions quite satisfactorily and without serious extraneous noises when used on a radio-gramophone belonging to one of my friends.

Can you suggest a probable cause of the trouble? S. G. T.

Excessive scratch is often brought about by misalignment of the pick-up carrier, and we believe that attention to this detail will overcome, or at any rate mitigate, your trouble.

An accumulation of dust in the record grooves generally brings about a similar effect, and if you have not already done so we suggest that you will find it worth while to obtain a proper cleaning brush.

o o o o

Coils and Convolutions.

I am winding a pair of H.F. transformers on similar lines to those described for the "Record III," but, due probably to the fact that a different method of construction is adopted, have become confused both with regard to the method of connecting the various windings and their direction.

I think that part of my trouble is due to the fact that the drawings show sectional windings, which are possibly easy enough to follow when copying the exact design, but are confusing in my own case. Would it be possible for you to give me a rough sketch showing these points in simplified form? L. W. B.

We hope and think that this matter will be made clear to you by a consideration of Fig. 1, which shows all the windings for both medium-wave (M.W.) and long-wave (L.W.) windings.

Confusion is most likely to arise when dealing with the neutralising sections, particularly with the single turn used for the medium band. It is convenient to consider these windings as continuations of the primaries wound in the same direction, and, in an attempt to make this matter more clear, we have shown by a dotted line an imaginary continuation between the two coils, although in actual fact there is no direct electrical contact. It makes no real difference, either to the direction of winding or to the ultimate connections of the various ends, whether the coils are in the form of single-layer solenoids or in sections.

Primary, secondary, and neutralising coils are connected in series, and arrangements are made to short-circuit all the latter when receiving on the medium band.

In our drawing, external connections are indicated by lettering corresponding with that appearing in the diagrams of the original article.

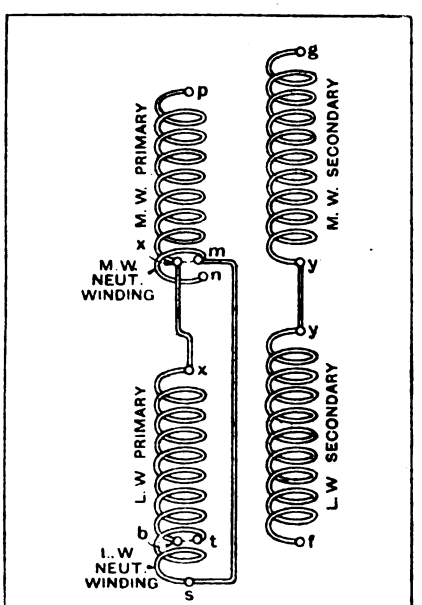

Fig. 1.—Sketch showing arrangement of combined medium- and long-wave transformers for the "Record III." Special attention should be paid to the direction of windings and connections of the neutralising coils.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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H.T. Supply for the 1930 Everyman Four.

With a view to equalising the discharge of the cells in my 180-volt accumulator H.T. battery, I should like to arrange matters so that the necessary voltage-dropping devices are included in the set, in order that only one positive H.T. connection to the battery need be made.

I already have a 50,000-ohm. wire-wound potentiometer, and take it that this component will be suitable for making critical adjustment of screening grid voltage. E. B.

A skeleton circuit diagram showing the necessary modifications to the anode circuits is given in Fig. 2; your present potentiometer will do quite well for regulating screen voltage, but will pass a rather heavier current than is absolutely necessary, and some economy may be effected by inserting in series with it a fixed resistance of about 50,000 ohms at the H.T. positive end.

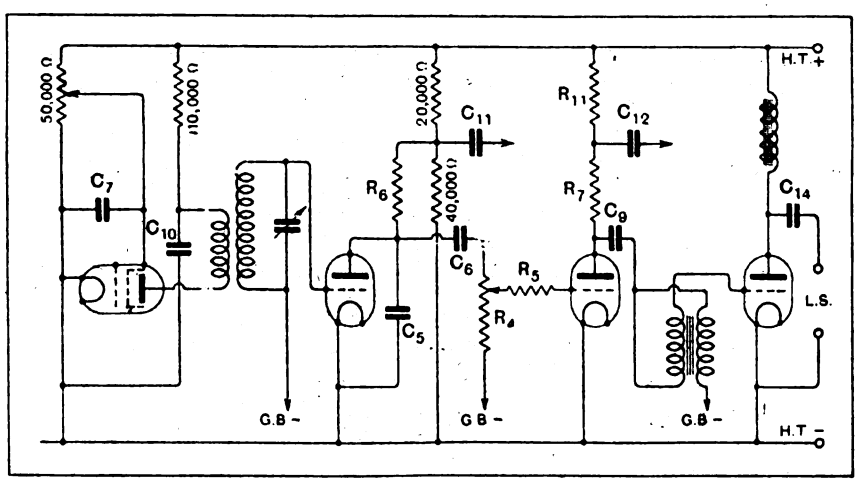

Fig. 2.—The 1930 Everyman Four arranged for a common H.T. supply, with voltage-regulating devices included in the receiver.

We have shown a potentiometer feed for the anode bend detector; this is not essential, but is distinctly to be recommended where a considerable voltage is to be absorbed.

Regarding the resistance in the H.F. valve anode circuit, we have shown a value of 10,000 ohms; this will be approximately correct for the majority of present-day valves, but a value of 20,000 ohms might possibly be necessary. In any case, the exact value of this resistance can be calculated with the help of the information provided by the manufacturers of your valve.

o o o o

An Up-to-date All-wave Four.

Will you tell me if a modernised version of the New All-Wave Four has yet been described in your journal? R. C. J.

We have not published any specific information on altering this set, but it can be safely assumed that any modifications would be almost exactly similar to those found to be desirable in modernising the Everyman Four. The 1930 Everyman Four, described in our issue of October 16th, may equally well be considered as a "this year's model" of the All-Wave Four.

o o o o

Condensers Out of Step.

I have been considering the design of the "Record III" receiver with a view to "lifting" several of its features for my own receiver, which is in course of reconstruction. One point puzzles me: is it not a fact that the variable condensers C_2 and C_3 cannot possibly operate in step with each other? I say this because their capacities are identical, whereas the inductance of the coils across which they are shunted is different. If this is correct, do you consider that the lack of synchrony is a serious disadvantage? M. C. S.

What you say is quite correct, but in a highly specialised design of this sort it would be a difficult matter to arrange for synchrony, and in view of the fact that the tuning of the H.F. coupling is comparatively broad, the point cannot be considered as of any great importance.

o o o o

Tuning Intervalve Couplings.

I notice that, in tuning H.F. coupling transformers, it seems to be common practice nowadays to use condensers with a capacity of not more than 0.0003 mfd., whereas a year or two ago capacities of 0.0005 mfd. were generally employed. Why is this? J. W.

By maintaining a comparatively high ratio of inductance to capacity, magnification is increased, and side-band attenuation is reduced. Both these factors are to the good, but unfortunatly circuits designed on this plan tend to be less selective; this difficulty is nowadays overcome by providing more selective input arrangements than hitherto.

Single H.T. Supply.

Is there any objection to increasing the values of the decoupling resistances in the 1930 Everyman Four, so that a common voltage may be applied to all the anode circuits from an accumulator H.T. battery? E. T. C.

As far as the anode circuits of the H.F. and first L.F. valves are concerned, this plan is quite in order. There would be no serious disadvantage in applying it to the detector valve if the voltage to be absorbed in the resistance is not very great; but it would be better, both for this circuit and for the screening grid, to include a potentiometer rather than a simple series resistance.

o o o o

Filament Transformer Output.

I have a step-down low-tension transformer with a rated output of 8 amperes at 4 volts; would it be quite safe to use it in the construction of a three-valve A.C. set, for which the total current consumed by the heaters would be only 3 amperes? T. S. W.

This depends on the voltage regulation of your transformer, and we would not like to offer a definite expression of opinion. Unless the regulation is good, the voltage will rise considerably if the load imposed on the secondary is considerably less than that for which it is apparently designed. We suggest that you should consult the makers.

FOREIGN BROADCAST GUIDE.

RADIO PARIS

(France).

Geographical position: 48° 50′ N. 2° 20′ E.
Approximate air line from London: 214 miles.
Wavelength: 1,725 m. Frequency: 174 kc. Power: 12 kW.
Time: Greenwich Mean Time.

Standard Daily Transmissions.

6.45 and 7.30 a.m. Physical Exercises (ex. Sunday); 8 a.m. news; 12.30 concert; 15.45 concert; (Sundays: 15.30); 18.30 gramophone records; 20.15 or 20.30 main concert.

Male announcer: *Allo! Allo! Ici Emissions Radio Paris de la Compagnie Française de Radiophonie.*

Opening signal: Several strokes on gong, followed by Westminster chimes, the latter repeated before all main transmissions.

Time signal: Twelve short sharp dashes, the last one indicating half or full hour.

When closing down the announcer's last words are: *Bonsoir Mesdames, Bonsoir Mesdemoiselles, Bonsoir Messieurs,* usually followed by the "Marseillaise."

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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THE THIRST FOR POWER.

AT the recent Conference at The Hague the International Consultative Committee which deals with the technical aspect of radio communication classified the wireless wavelengths and also made the decision to limit the broadcasting energy of telephony transmitters to 100 kW. It would seem that having once set this enormous power as a maximum this is being regarded as the ultimate goal to which the broadcasting organisations of Europe should aim, without consideration of whether or not it is for the ultimate benefit of listeners in general. Some short time ago, writing under the title of "The Battle of the Giants," we pointed out the unfortunate effects which appeared to be inevitable as a result of individual European States acquiring higher powered broadcasting transmitters.

Far from curbing the ambitions of some countries to install giant transmitters, the recent decision at The Hague tends to support this race for power, and it does not require much imagination to visualise the increasing difficulties in the way of distribution of broadcasting services in the near future as the number of giant transmitters increases.

In the earlier days of broadcasting, both in the United Kingdom and on the Continent, the pioneers were satisfied with the erection and operation of stations providing from 1 to 1½ kW. in the aerial. Germany, we believe, was the first country to increase the power of its stations, and still to-day has retained 4 kW. transmitters as a general standard. As other countries in Europe began to put up broadcast transmitters their inclination was to copy or improve upon the example set by Germany, and so 5 and 10 kW. transmitters became quite usual. The schemes which have now been put forward by some of the principal European countries for improvements in their broadcasting organisation all call for higher power transmitters. Germany has until recently implied that the range of the German broadcasting stations was adequate for her requirements, but latterly this view has been modified and a reorganisation of the German broadcasting system is, we understand, now contemplated, having as its object the establishment of a number of transmitters of very much higher power.

Shouting One Another Down!

The German scheme is to install the new high-power stations as additional to the present transmitters and to combine them into groups, the lower-power transmitters operating on national common wavelengths with the high-power station of each group. In view of the energy which Germany has already shown in the development of her broadcasting system there seems little reason to doubt that we shall shortly be faced with a position where the German transmitters will once more dominate Europe and stimulate other States to follow her example.

These changes are coming about in spite of the fact that the insensitive crystal receiver is dying out and being replaced by valve sets which are capable of satisfactory reception over greater distances without so much necessity for high power at the transmitting end. The higher the power of a station, generally speaking, the more costly is its construction, and consequently the harder would it be to bring about a modification of the European broadcasting system in favour of lower power when at a later date the need for some such change becomes urgent. So far our own reception of the British broadcasting transmissions has not been seriously interfered with, but, as the giant stations rise up nearer and still nearer to our shores, it seems inevitable that we shall no longer be able to remain indifferent to the menace.

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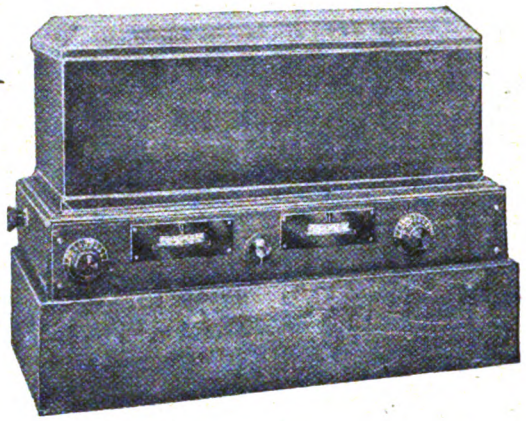
Wireless World A Kit Set



Mains Model

Minor Circuit Alterations.

Constructing the Eliminator.

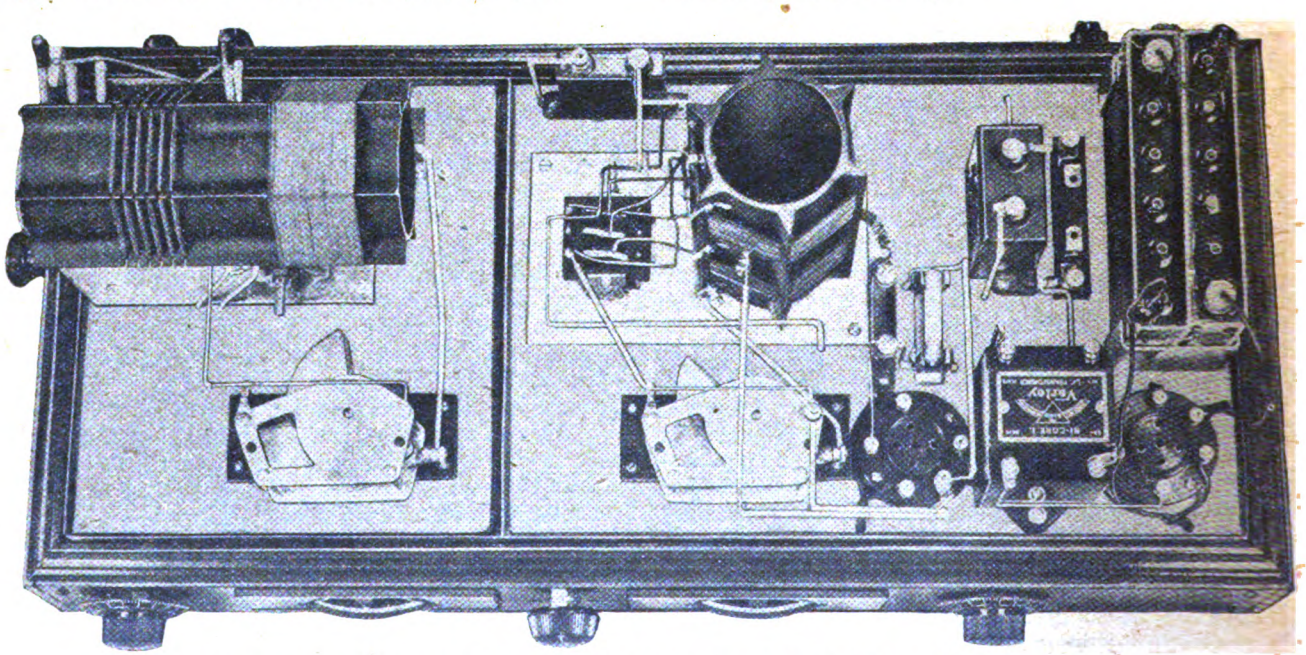
THE following design is given in response to numerous requests from readers for an A.C. version of the "Kit Set" described in the issues for September 18th and 25th.

Essentially the circuit remains the same. It has been found that the turns given for the tuning coils and H.F. transformer function equally well with indirectly heated valves. The only alterations are concerned with the method of volume control, the biasing of the detector valve, and the loud speaker feed. With A.C. valves, of course, the filament control of the screen-grid valve as a means of volume control must be abandoned. Its place is taken in the present design by a potentiometer arrangement controlling the potential of the screen-grid. For this purpose a 50,000-ohm moulded resistance is used in conjunction with a variable wire-wound resistance of maximum value, 25,000 ohms. This ensures that the maximum screen-grid potential specified by the valve makers is not exceeded, and at the same time gives an exceedingly smooth control of volume from zero upwards.

The resistance values in the circuit are suitable for valves in the Marconi series with indirectly heated filaments. The first valve is an M.S.4, the detector an M.H.L.4, and the power valve an M.L.4.

By a merciful dispensation, grid current starts in the M.H.L.4 with the grid slightly negative. If the anode potential is kept between 50 and 75 volts it is possible to work this valve as a leaky grid detector with the grid returned to cathode, i.e., with zero grid bias. This conveniently solves what would otherwise be a troublesome problem; there is no further need for the grid potentiometer specified in the original design, neither do we require a separate cell for positive bias.

The M.L.4 is an output valve of the same calibre as the P.625, and is capable of driving a moving-coil loud speaker. The filter feed circuit was introduced primarily with the object of keeping strong L.F. currents out of the eliminator, but it also serves the useful purpose of by-passing the steady anode current of about 18 mA. from the loud-speaker windings.



Plan view with valves removed. The grid bias batteries are now mounted inside the right-hand compartment.

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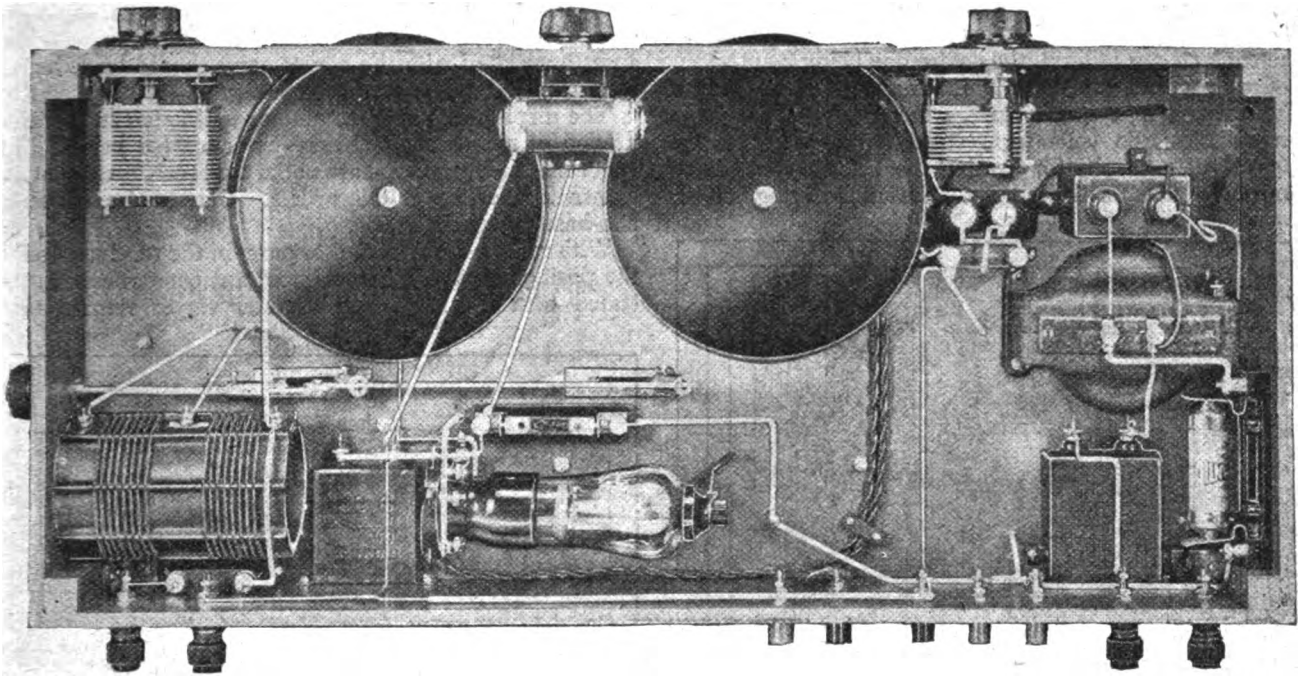

View underneath the base showing choke filter output circuit and shrouded terminals for connections to the eliminator.

Some revision of the anode feed arrangements has been found necessary. There are still two positive H.T. tappings in order that additional smoothing may be provided for the detector. Connections between the receiver and the eliminator are made through shrouded plugs and sockets instead of terminals, so that if the eliminator is inadvertently switched on with the leads disconnected no damage can result through short-circuiting.

The eliminator is built in a simple tinned-iron case, details of which are given in Fig. 6. The base is of three-ply covered with tinned iron lapped over the edges. The cover pushes down over the edges of the base and is secured at one corner by a length of 2B.A. screwed rod and in the diagonally opposite corner by a wood screw driven into the edge of the vertical sub-panel supporting the mains transformer. This transformer is mounted horizontally, and the end carrying the terminal strips is supported from the base by small brass feet, one of which is used for earthing the core to the metal base. Although a five-pin horizontal valve holder similar to that used for

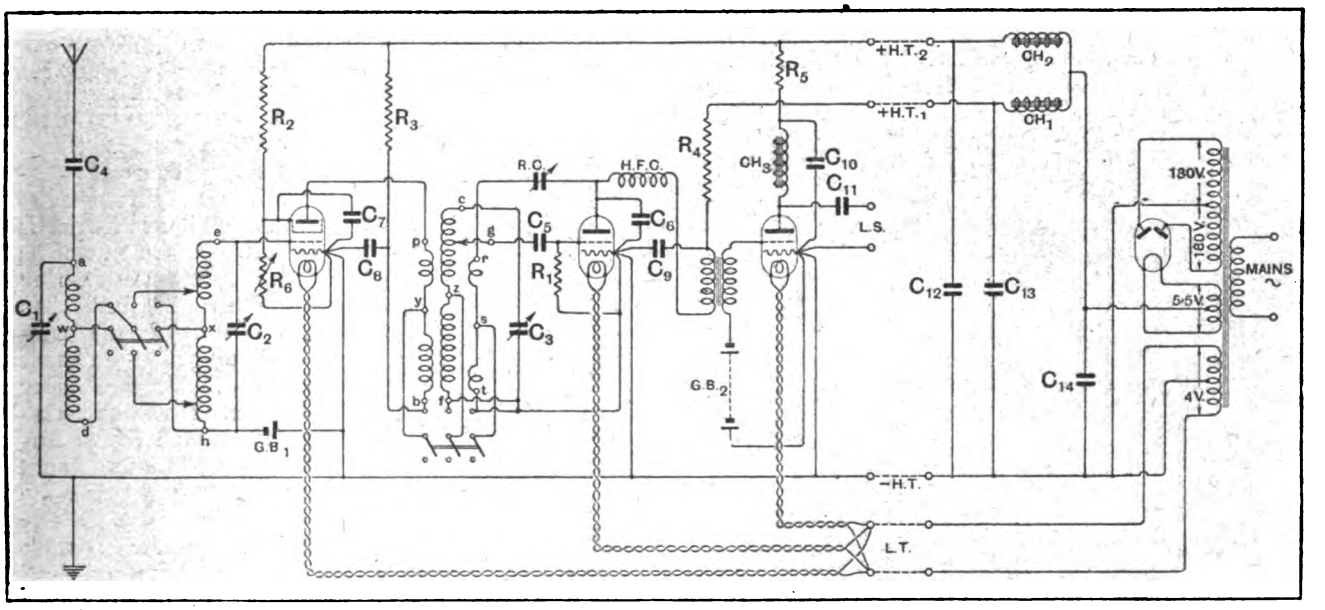

Fig. 1.—Complete circuit diagram of receiver and eliminator unit. C_1, 0.0005 mfd.; C_2, C_3, 0.0003 mfd.; C_4, C_5 0.0003 mfd.; C_6, 0.0001 mfd.; C_7, C_8, 0.1 mfd.; C_9, C_{10}, C_{11}, 2 mfds., C_{12}, C_{13}, 2 mfds. (500v. A.C. test); C_{14}, 4 mfds. (500v. A.C. test); R_1, 2 megohms; R_2, 50,000 ohms; R_3, 600 ohms; R_4, 50,000 ohms; R_5, 1,000 ohms; R_6, 25,000 ohms maximum; CH_1, 110 henrys; CH_2, CH_3, 32 henrys.

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The Wireless World Kit Set A.C. Mains Model.—

the screen-grid valve has been specified, only four of the contacts are utilised, the centre one being ignored.

Current from the A.C. mains is fed to the Parmeko Type No. 2 A/2 transformer, which provides windings giving 180+180 volts for rectification by a full-wave U5 valve, 5.5 volts for heating the U5 filament and 3 amps at 4 volts for the indirectly heated receiving valves.

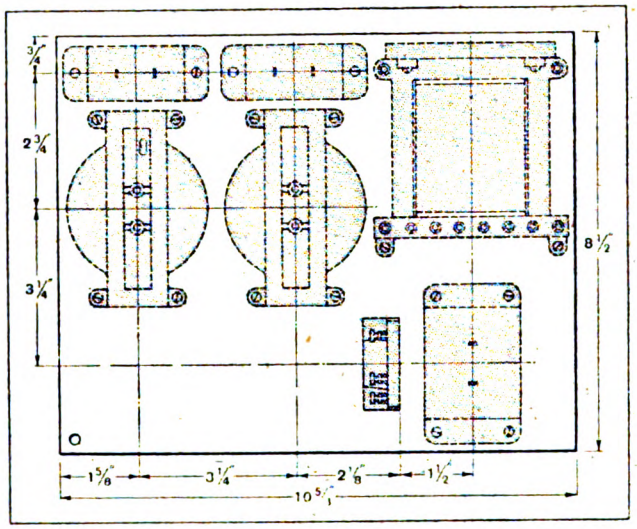


Fig. 2.—Layout of components in eliminator unit.

After rectification the H.T. current is smoothed first by a 4 mfd. condenser tested at 500 volts A.C. and designed to work on 250 volts A.C., and then divides through a 32-henry choke to the H.F. and output valves and through a 110-henry choke to the detector. Additional smoothing is provided on the receiver side of each choke by 2 mfd. condensers, also rated for a working voltage of 250 A.C. To avoid the possibility of shocks in the event of any fault developing in the eliminator, the transformer core and the common negative lead are bonded to the case at E (Fig. 3). No switch or fuses have been included as a switch on the eliminator itself leaves the mains leads live. The set should be switched off at the main, and the fuses associated with the power point should be reduced to 1 or 2, and at the most 5 amps.

The disposition of the eliminator unit is left to the discretion of the reader. It may be concealed behind the set or mounted in a sub-base under the receiver cabinet as shown in the title of this article. Details of a suitable sub-base are given in Fig. 7.

With regard to the layout of parts in the receiver itself, the position of all the more important components associated with the H.F. and detector stages remain unchanged, the majority of the alterations being confined to the output end of the receiver. The grid bias batteries are now mounted inside the screening box to leave room for the output choke and feed condenser underneath the base. The on-and-off switch is omitted from the front panel, and a 25,000-ohm Varley "Power" resistance takes the place of the filament rheostat. Incidentally, the 25,000-ohm resistance is the last component to be fitted. After the wiring underneath the base has been completed the condenser tuning dials are fitted, and then finally the Varley resistance. It will be necessary to remove the perforated cover, which would otherwise project below the base.

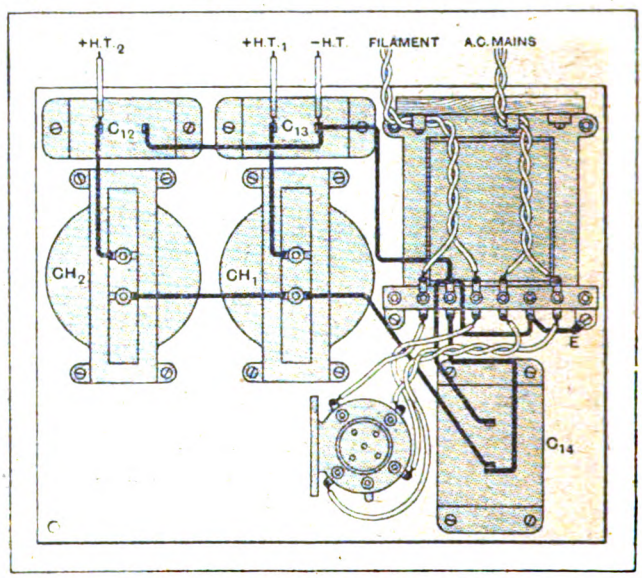
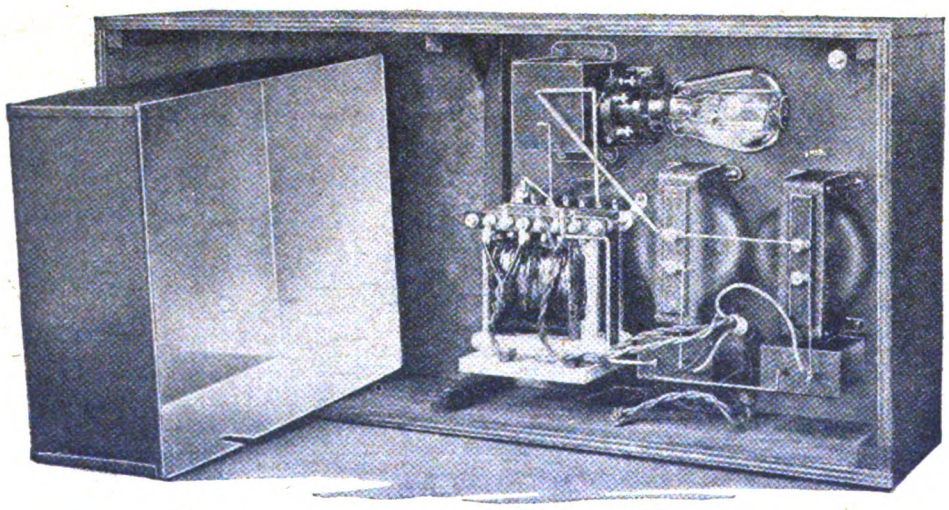


Fig. 3.—Wiring diagram of eliminator unit.



Eliminator with cover removed showing method of mounting in suggested sub-base.

The measured output H.T. voltage from the eliminator when working into a load equal to that of the receiver, turned out to be

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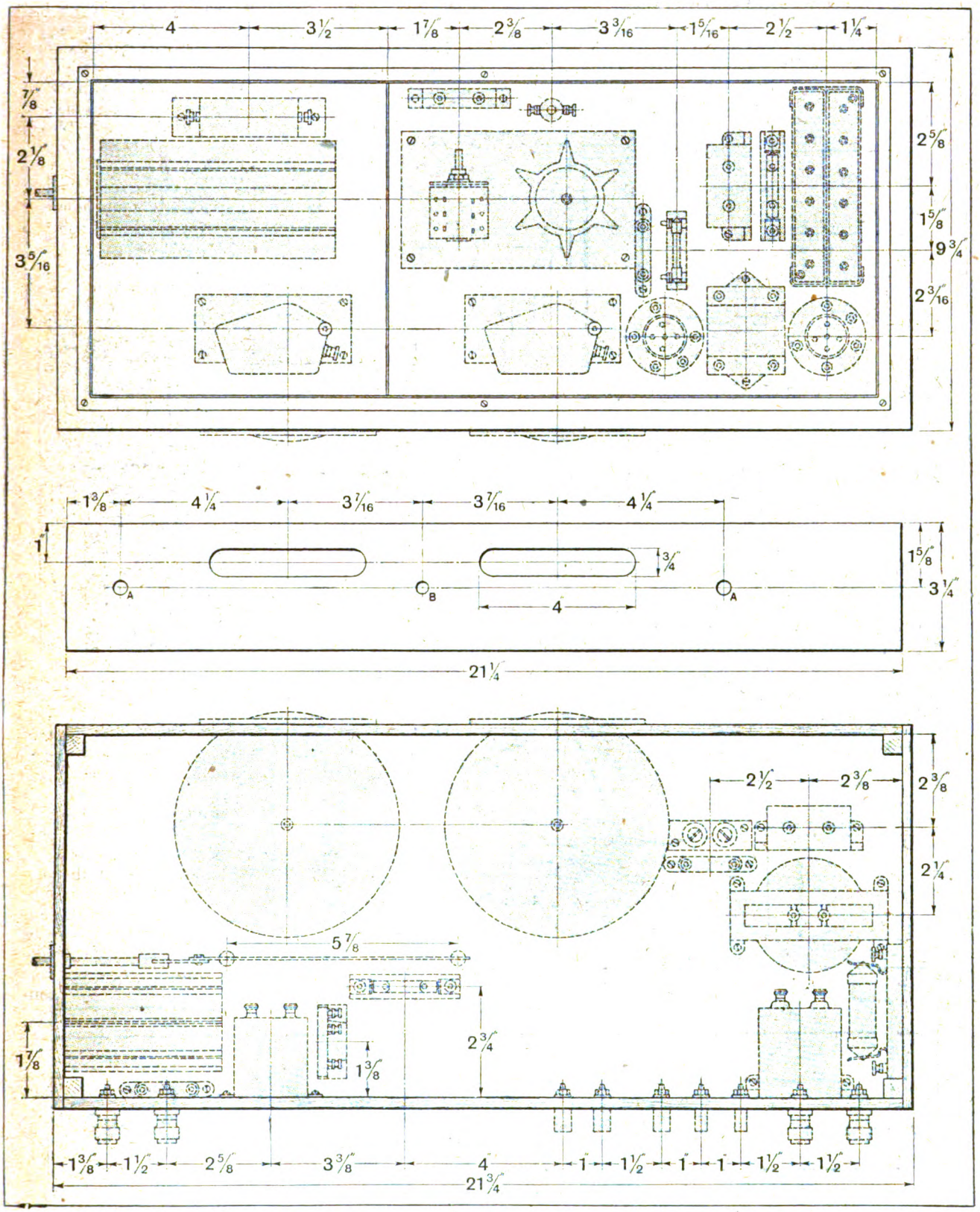

Fig. 4.—Dimensioned layout of components above and below the receiver panel. A = 3/8in. dia.; B = 5/16in. dia.

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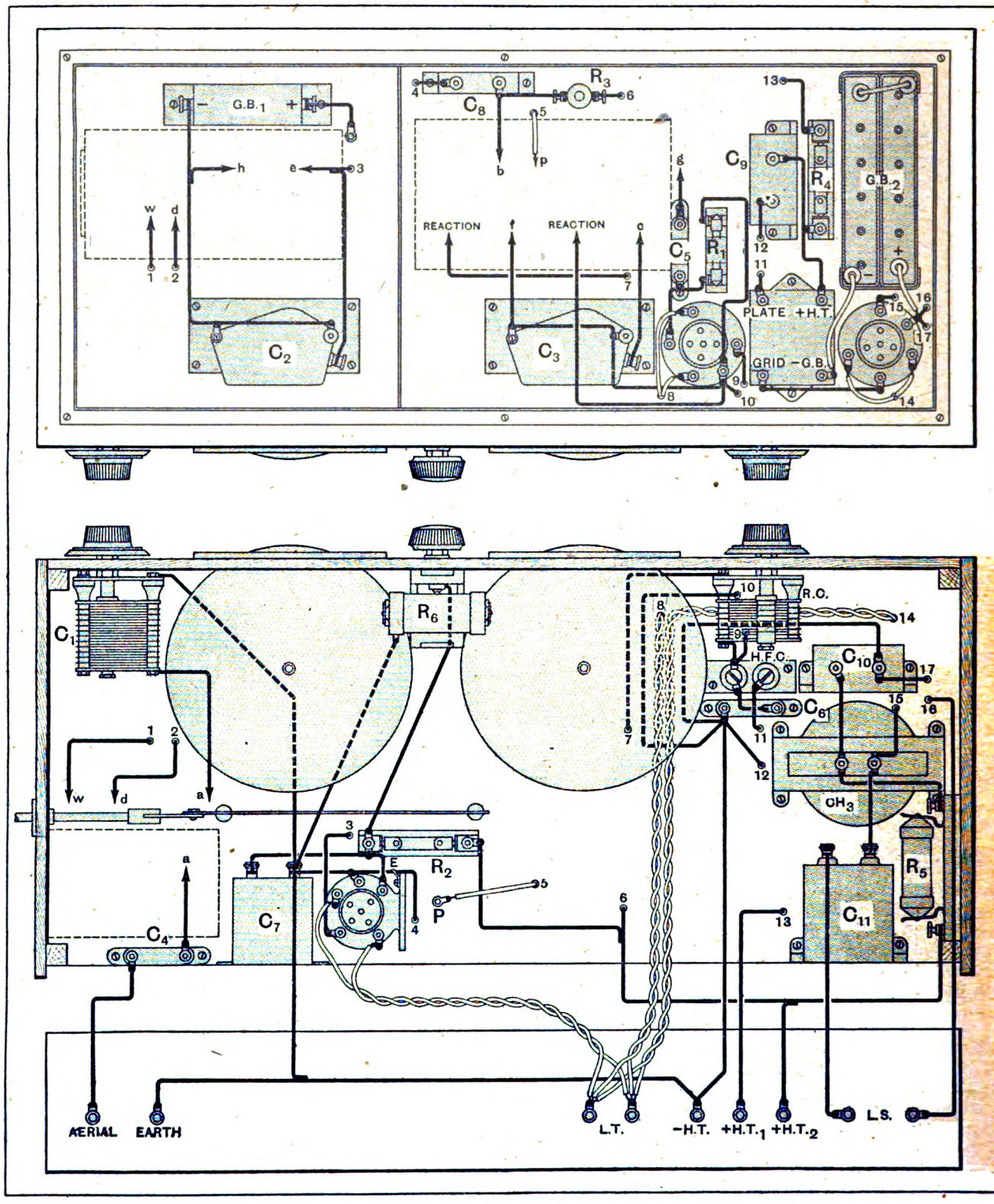

Fig. 5.—Complete wiring diagram of receiver. Wires passing through the base are identified by corresponding numbers, and connections to the coil units are indicated by letters corresponding to the coil details on page 262 of the September 18th issue. The common negative lead is earthed to the metal base at E through one of the fixing screws of the S.G. valve holder.

B 16

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LIST OF PARTS.

1 Kit Set cabinet (Ritho).
3 Kit Set coils complete (Wearite).
2 Variable condensers, 0.0003 mfd., Type No. 3 (Polar).
1 Variable condenser, 0.0003 mfd. (Utility "Mite" miniature plain).
1 Variable condenser, 0.0005 mfd. (Utility "Mite" miniature plain).
1 Pair dials and Escutcheon plates (B. & J.).
2 Valve holders, 5-pin, baseboard mounting (W.B.).
2 Valve holders, 5-pin, Universal (W.B.).
1 Fixed condenser, 0.0001 mfd., mica (T.C.C.).
1 Fixed condenser, 0.0002 mfd., mica (T.C.C.).
1 Fixed condenser, 0.0003 mfd., mica (T.C.C.).
2 Fixed condensers, 0.1 mfd., 400 volts D.C. test (T.C.C.).
3 Fixed condensers, 2 mfd., 400 volts D.C. test (T.C.C.).
2 Fixed condensers, 2 mfd., 500 volts A.C. test, 250 volts A.C. working
1 Fixed condenser, 4 mfd., 500 volts A.C. test, 250 volts A.C. working (T.C.C.).
2 Moulded resistances, "Met-Vick," 50,000 ohms, and holders (Ediswan).
1 Anode resistance, 1,000 ohms, and holder (Ferranti).
1 Decoupling resistance, 600 ohms (Wearite).
1 Grid leak, 2 megohms (Ediswan).
1 Porcelain base for above (Bulgin).
1 Power potentiometer, 25,000 ohms (Varley).
1 H.F. choke, Binocular Junior (McMichael).
1 S.G. cell, 0.9 volt (Siemens).
2 Grid bias batteries, 9 volts (Ever-Ready).
1 Intervalve transformer (Varley, "Nicore I").
2 L.F. chokes, 32 henrys (Pye).
1 L.F. choke, 110 henrys (Pye).
1 Mains transformer, Type No. 2, A/2 (Parmeko).
1 Rectifier valve, U.5 (Marconi).
1 MS4 valve (Marconi).
1 MHL4 valve (Marconi).
1 ML4 valve (Marconi).
4 Ebonite shrouded terminals (Belling-Lee).
5 Safety plugs and sockets (Belling-Lee).
4 Wander plugs (Belling-Lee).
Wire, Sistoflex, twin flex, lamp adaptor, screws, etc.
Material for eliminator, screen and sub-base.

Approximate cost, including valves, £19.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer, and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

189 volts. With this voltage on the anode of the M.L.4 output valve a bias of −18 volts is not quite enough.

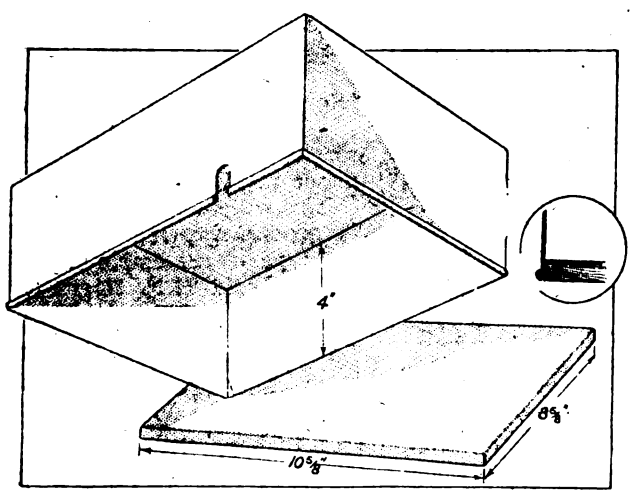

Fig. 6.—Leading dimensions of tinned-iron case for eliminator unit. The base is a piece of three-ply wood with the metal lapped over the edges. The leads are bound with insulating tape or sleeving and passed through a slot in the cover.

Accordingly a 1,000-ohm resistance has been introduced in the anode circuit. This in conjunction with the D.C. resistance of the chokes reduces the voltage on the anode to about 165, for which a bias of −18 volts is suitable. At the same time, the 1,000-ohm resistance and its by-pass condenser assist in smoothing and provide a measure of decoupling for the last stage in addition to that provided by the choke-feed output.

For a full description of the method of tuning, the reader is referred to the article on page 307 of the September 25th issue. With the A.C. valves specified, the performance is quite equal to the standard set by the original set. There is a slight tendency to instability towards the bottom of the long-wave range which suggests a revision of the long-wave primary turns. It is simpler, however, to reduce the screen-grid volts slightly, and this can be done without serious detriment to range or quality.

The eliminator, even when mounted immediately below the receiver, functions without the slightest trace of hum, and there is the same absence of background noise as in the original battery model.

The values of resistance specified for the screen-grid potentiometer give a range of 0 to 63 volts for the screen-grid potential. For screen-grid valves requiring a higher potential a Varley resistance of maximum value 30,000 or even 50,000 ohms should be used.

With a 50,000-ohm resistance in series with the detector valve a measured anode current of 2.8 mA. was obtained with the particular valve used showing the anode volts to be 49; a convenient value for grid rectification with zero grid bias. A higher anode voltage and +1½ volts grid bias were tried, but without any definite improvement in efficiency.

This receiver is available for inspection at the Editorial Offices, 116-117, Fleet Street, London, E.C.4.

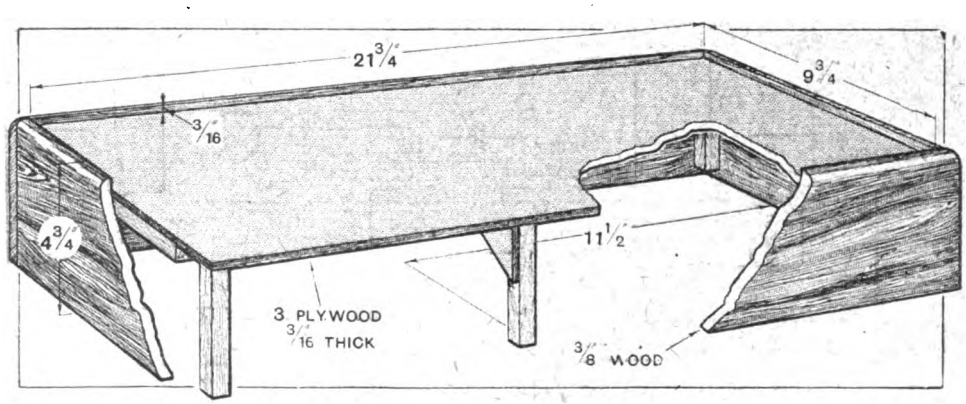

Fig. 7.—Suggested sub-base for housing the eliminator underneath the receiver.

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THE SELECTIVITY — QUALITY PROBLEM

A Useful Hint on the Controlling of an Anode-Bend Detector.

By BERTRAM HOYLE, M.Sc.

THERE is a distinct indication in modern wireless receiver design of a tendency to follow one of two divergent policies. One is to design a very perfect musical reproducer, which has of necessity to sacrifice extreme selectivity and range, making it more or less a local station and 5XX set with nearly perfect side-band retention. The other is to design a wireless set from the point of view of obtaining most broadcast transmissions in Europe, both musical and otherwise, and that has a selectivity such that it can tune in to the centre of a distant transmission situated some 8 or 10 kc. away from some much more powerful transmission and still leave no background of the latter.

Briefly the object of this article is to demonstrate how to obtain better quality from a receiver adjusted to a state of "apparent selectivity"; which, if obtained in the usual "wireless" way, and without due regard to circuit conditions, would lead to a distressing lack of high notes.

A wireless set in which this is brought about by virtue of its highly selective tuning apparatus must of necessity, completely cut out all the side-band frequencies approaching 5,000 cycles. This causes the distant station to take on quite an unnatural tone; boominess being a mild description of the malady, especially if on a coil-driven loud speaker. There must be many potential set builders who are divided in their choice between the two limiting types of set above mentioned.

The writer, whose chief aim is good-quality music, favours the type of set employing two screened-grid H.F. stages (one tuned-anode, one transformer stage), anode-bend detector and two low-frequency stages.

Fig. 1 indicates the essential parts of the detector and associated circuits and their constants. Scientific wiring is used for all H.F. and L.F. components. Decoupling resistances and condensers are inserted at all danger points.

High notes are well retained by employing only medium-loss coils in the H.F. part of the set, so that there is no great selectivity. The PM6D valve worked with low anode resistance also helps in the retention of high notes together with as small a capacity from anode to negative filament as practicable, such as 0.0001 mfd., or less in the case of really strong transmissions. Low notes are generously provided for by the use of a 0.1 mfd. mica feed condenser to the grid of a P625 as the penultimate valve. This valve is made to work at 250 volts with 20 mA., and has a specially constructed choke giving

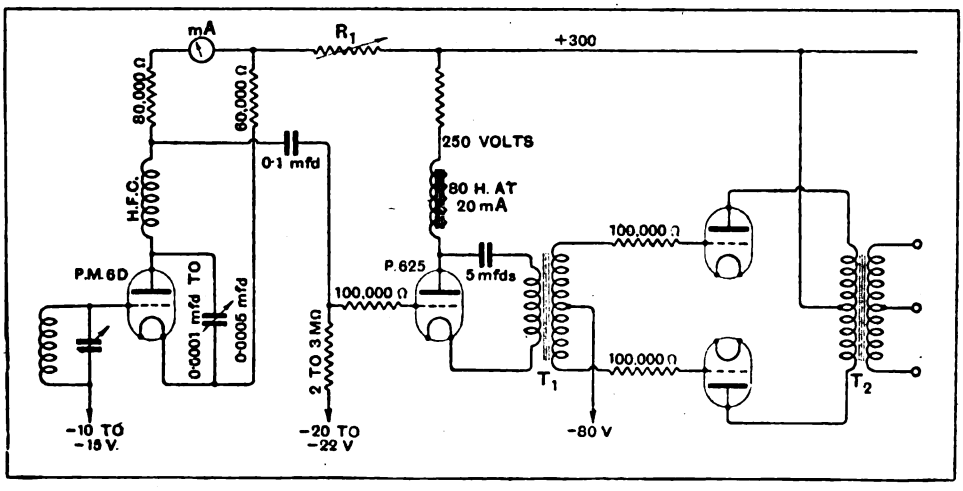

Fig. 1.—Suggested detector and L.F. stages of receiver designed for quality reception. Suitable values are given, but decoupling and filament wiring is omitted.

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The Selectivity-Quality Problem.—

80 henrys at 20 mA. in its anode circuit. The fact that this choke is run well off the saturation point[1] and the transformer (a Ferranti AF5C) carries no magnetising current again helps in low-note retention.

To revert to the point of these notes, namely, high selectivity with good quality. The writer, in using this set at first, definitely did not attempt to listen to stations of good strength, with only 10 kc. separation, as there was sufficient overlap to cause trouble, the H.F. coils as already mentioned being made purposely not low-loss coils. Neither is the set used on any transmission that may be weak at the time that it is wanted. There are now many strong stations rather closely placed on the long-wave band which would be well worth listening to at times; but the selectivity demanded is such that their quality is impaired by the time they are tuned in.

To take a concrete example, Berlin, Konigswusterhausen 183.5 kc. (1,634.9 metres) is received in England at very considerable strength, but is only separated by 9.5 kc. from Daventry 5XX, which is immensely stronger.

By putting up the detector bias and by close adjustment of the voltage applied to the detector from the potentiometer (R_1 in Fig. 1), a state of affairs can be reached where there is a very definite cut-off of all

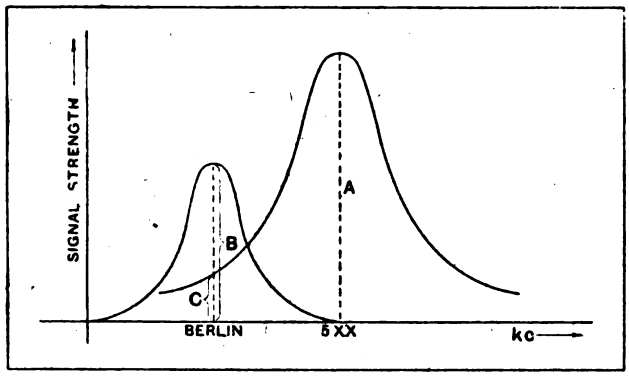

Fig. 2.—Comparative strengths of 5XX(A) and Berlin(B) at point of maximum tuning. The strength of 5XX when the circuit is tuned to Berlin is represented by C. This interference must be rejected by the detector.

signals below a certain strength. This means that on tuning in to Berlin, say, on this none-too-selective receiver, the signal strength (in tune with Berlin) is B, and the strength of Daventry at this tune point is C (Fig. 2). A suitable bias and characteristic to enable the desired cut-off to be obtained is revealed in Fig. 3.

In the example chosen the strength of signal C from 5XX is insufficient to reach the rectification point of the characteristic in use; whilst the strength of that from Berlin is B, and is made sufficient to reach a reasonably straight part of the characteristic to be rectified. To do this requires a not very selective set, with two good H.F. stages and fairly strong transmissions to work on, and a fine control of detector volts. Then if the fringe of an unwanted station gives a strength C (Fig. 2), whilst the wanted one gives a strength B

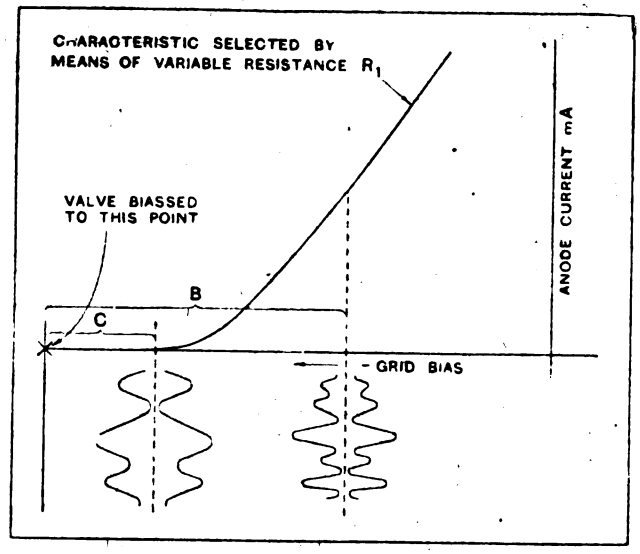

Fig. 3.—The weaker interfering signal C is removed by increasing the value of grid bias or alternatively decreasing the anode circuit.

several times greater, it is quite easy to obtain the clear, crisp quality usually associated with a non-selective set, combined with a high order of "apparent" selectivity.

The chief drawbacks to making use of this device are:

(1) That it is another knob to control, and it tunes rather critically.

(2) That the set when left in this condition is insensitive unless all tuning dials are critically operated together.

Normally, if any two dials get near a station's setting something is heard of it, and one can proceed to get it easily. Very close logging would be necessary if much use were to be made of the method. Using the PM6D and a bias of -15 to -18 volts enables one up to keep up the detector anode voltage to about 150, which gives a very straight line characteristic and, therefore, excellent purity when signals are put on to it.

Those who would like to obtain better quality from stations otherwise too close together in wavelength to permit of it being accomplished without too highly selective coils and circuits, should try a few experiments on the above lines of using variable bias and H.T. voltages, reducing the H.F. selectivity if necessary to regain the high notes.

[1] The choke contains 3½ lbs. of copper and 11 lbs. of iron.

***NEXT WEEK'S ISSUE** will include a number of specially written articles dealing with the problems of amplification and distortion. A* **VALVE DATA SUPPLEMENT** *which accompanies the issue will prove of particular value at the present time owing to the many changes recently made by the valve manufacturers. Previous valve data supplements have been extremely popular and the new method of presentation now being adopted includes practical information helpful to the amateur so that this reference chart becomes indispensable in the selection and operation of valves.*

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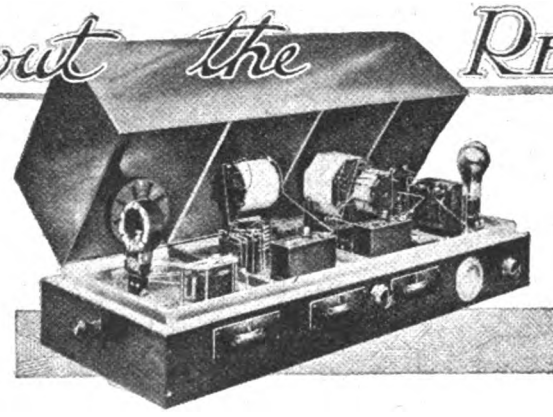
More About the RECORD III



Operating Notes and Hints to Constructors.

By H. F. SMITH.

THE builder of a set like the Record III [1] gets something more than the mere satisfaction of attaining the maximum sensitivity from its single high-frequency stage. Until the price of screen-grid valves reaches an appreciably lower level than that prevailing to-day, the single high-efficiency stage is likely to appeal, not perhaps so much on the score of reduced initial outlay as on the question of upkeep cost. No one should belittle the advantages of the multi-stage cascade high-frequency amplifier, but there are several reasons against its general adoption in this country—particularly in cases where other and perhaps simpler methods will yield the desired results.

No published receiver design can ever fully meet the precise requirements of everyone who may consider its main features to be attractive, and consequently it will be as well to devote a few words to modifications—permissible and otherwise. At the outset it should be made quite clear that anything approaching a sweeping alteration should be introduced with some hesitation and only if one has considerable experience. Liberties cannot be taken with impunity with a "500 times" H.F. amplifier; this holds good particularly with regard to screening, which can hardly be less complete than that of the original model, although there are admittedly other ways of carrying out this important part of the construction. At a pinch, it would be possible to dispense with a completely closed compartment for the aerial coils and their tuning condenser, but there remains the chance of undesirable interaction between these coils and those parts of the H.F. anode circuit—including the valve anode itself—which are of necessity exposed.

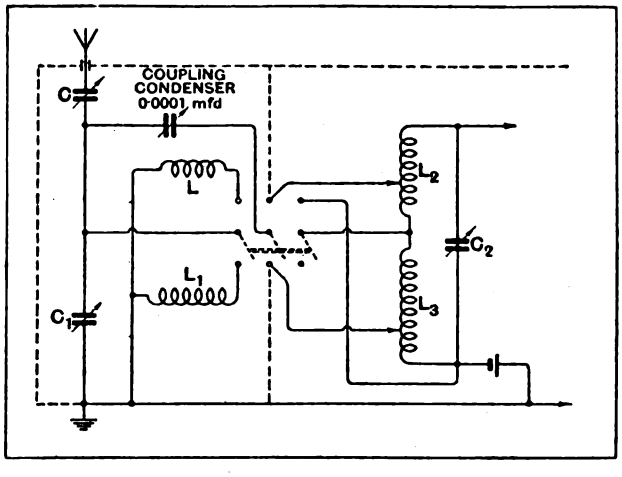


Fig. 1.—Aerial coupling may be continuously varied by the capacity-control method without any serious complication of the circuit arrangement.

[1] *The Wireless World*, September 4th and 11th, 1929.

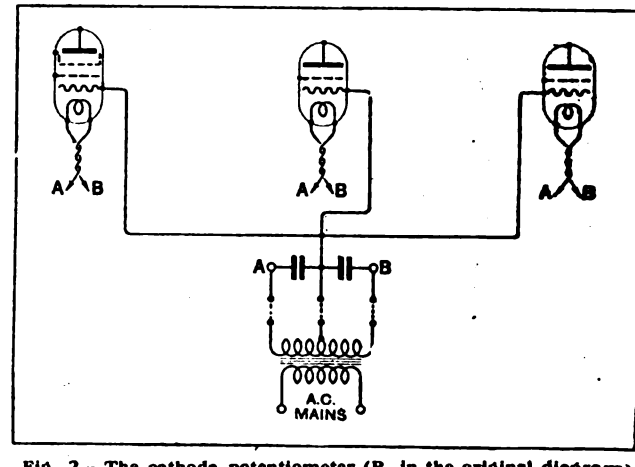


Fig. 2.—The cathode potentiometer (R, in the original diagram) may be omitted if a centre-tapped low-tension transformer is used.

Problems of Selectivity.

In order to provide high amplification without serious sideband cutting, the constants of the tuned intervalve circuit are such that this part of the receiver contributes less than usual towards its overall selectivity. This is inevitable, but, thanks to the provision of a separately tuned aerial circuit, the set is not particularly prone to interferences, and is, indeed, well above the average standard in this respect. In difficult situations, and when working on a wavelength close to that of a nearby station, it is a good plan to reduce aerial coupling (by moving the tap connection nearer the earthed end of the secondary coil) to a value rather less than that providing loudest signals.

In some cases it will be considered worth while to make provision for continuously variable aerial coupling, although experience shows that it is often wise to defer

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More About the Record III.—

this alteration till some practice has been had in the operation of the simpler semi-fixed coupling as described. Closed and open circuits may be linked through a small variable condenser in the manner familiar to most readers: this arrangement is much simpler than the alternative of using swinging coils, and does not greatly complicate the set. A suitable form of connection for continuously variable capacity coupling is given in Fig. 1, from which it will be observed that one pole of the wave-range switch is omitted. If a control condenser of the conventional capacity (0.0001 mfd.) is used, it will be necessary to move the taps on the secondary coils L_2 and L_3 towards their high-potential ends in order that sufficiently close coupling may be effected under all conditions.

Provided that a coupling condenser of sufficiently small overall dimensions is chosen, it may be mounted on the front panel, between the dials of C_2 and C_3.

Instead of picking up an artificial centre point on the heater transformer secondary by connecting the cathodes to a potentiometer slider it is quite permissible to use a centre-tapped winding in the manner shown in Fig. 2. The bridging condensers of 0.005 mfd. (C_{11} and C_{12}) used with the original arrangement must be retained, and should be mounted in the set itself rather than in the eliminator, in order to avoid long leads; this will necessitate a three-wire cable between receiver and external transformer.

Questions are sometimes asked as to the percentage of sideband loss at given audio-frequencies; unfortunately, anything in the nature of a definite reply is quite out of the question, as everything depends on how the input filter circuit is operated. Adjusted to the best advantage, there need be no appreciable loss; indeed, by very skilful operation it is possible to give emphasis to upper sideband frequencies. To make the best use of this valuable feature of the receiver, it is easiest first to tune in the desired signal with the loosest possible coupling between open and closed circuits, and then to tighten the coupling until tuning is appreciably broadened. If detector overloading is produced, a certain measure of control is afforded by reducing the capacity of the semi-variable aerial series condenser, afterwards retuning the open circuit. Incidentally, selectivity can be controlled to a certain extent by this adjustment, which should not be forgotten when interference cannot be cut out by methods already discussed.

It has already been stated that a very simple eliminator is suitable for supplying the set with high-tension current, thanks to the comparatively elaborate decoupling devices and to the fact that a single L.F. valve with a choke filter output is used. Tests have been made by introducing artificial resistance and inductance common to all anode circuits, and it has been found impossible to provoke either H.F. or L.F. oscillation. Of course, this is apart from the question of smoothing; reasonable precautions must be taken to obviate hum, but the receiver is not particularly prone to trouble from this source, partly because it includes H.F. transformer coupling.

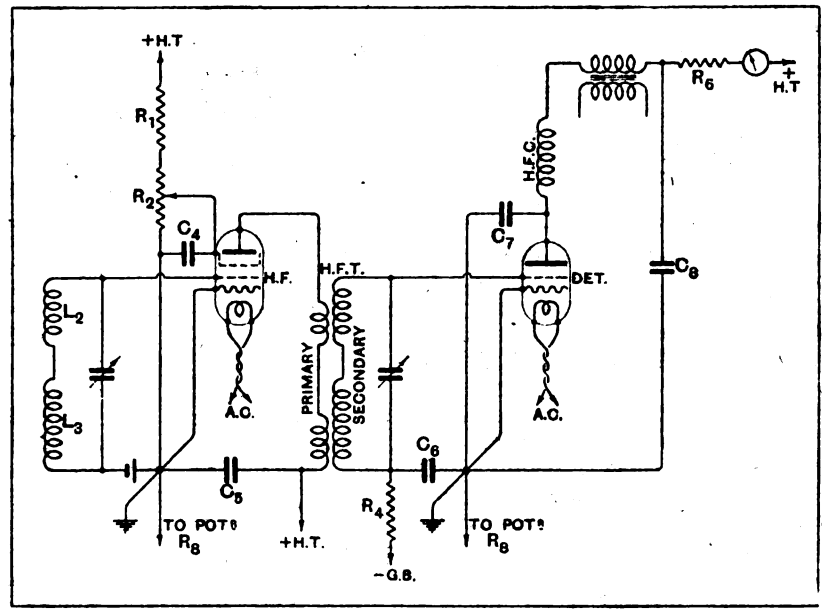

Fig. 4.—Danger points in wiring. Anode, screening grid, and grid oscillatory circuits are "returned" to the earthed cathode terminal of their own valve.

A suggestion for a suitable H.T. eliminator is given in Fig. 3. Here it is assumed that the power transformer will include a low-tension winding for feeding the heaters, as this is the most economical procedure except where an existing high-tension eliminator can be used.

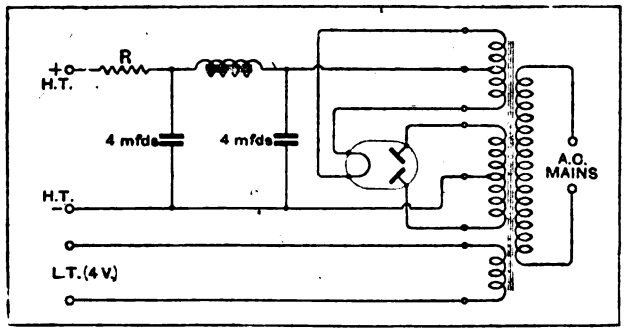

Fig. 3.—A simple eliminator suitable for the Record III. The value of the voltage-absorbing resistance R will depend on the rectified output and the H.T. current consumption of the receiver.

Safeguarding the H.F. Valve.

In the original article it was suggested that a common voltage of anything up to 180 might be applied to the receiver: it should, perhaps, be pointed out that this is rather in excess of the maximum specified for the H.F. valve by its makers, but, as the current consumed by a screen-grid valve is largely determined by screening grid voltage, this was not considered to be of great importance. To be on the safe side, there is no harm in substi-

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More About the Record III.—

tuting a voltage absorbing resistance of appropriate value for the 600-ohm decoupling resistance R_3 in cases where the maximum pressure is appreciably in excess of 150 volts. As an alternative, a separate high-voltage feed may be provided for the output valve.

Attention has already been directed to the need for thorough screening. Decoupling, or the isolation of individual oscillatory circuits, is almost as important, particularly in a high-magnification mains-fed receiver, and attention is drawn to Fig. 4, which shows how the high-frequency oscillatory components of plate and screening-grid circuits are deflected back to the cathode of the valve concerned. Similarly, it is vital that exposed grid and plate leads of H.F. and detector valves should be as short as possible, and it is for this reason that the connecting wires are passed through holes in the metal base immediately above their terminals.

Checking Transformer Windings.

The H.F. transformer windings are of necessity somewhat complicated, and, in the event of failure to balance the set, suspicion will naturally be directed to the connections of the neutralising coils. The writer can hardly do better than refer those who are in difficulties with regard to this admittedly rather bewildering business of multi-section windings to a simplified sketch in the "Readers' Problems" section of last week's *Wireless World*, which should make the matter quite clear.

While on the question of neutralising, an apparent inconsistency in the design should be explained. It may logically be asked why a balancing arrangement is provided on the long-wave side, although the "goodness" of the coils for this wave-band is admittedly no better than that of those used in other sets that need no adventitious aid to stability. The explanation is simple. A feed-back path is provided through the medium-wave balancing winding and its associated condenser; this cannot be avoided unless a rather complicated addition to the present switching is made, and consequently it was considered simpler to balance on both wave-bands.

Any difficulty in getting the receiver into a state of satisfactory operation is likely to have its source in the H.F. amplifier, but, due to the use of a "decapped" detector, it is inconvenient to test this valve by the method of substitution. In the event of trouble, it is useful to remember that the detector and L.F. amplifier can readily be tested by removing the flexible lead from the H.F. valve anode and joining this wire to the aerial *via* a 0.0001 mfd. fixed condenser. With this connection, the set should function as a detector-L.F. combination.

Several readers who require a somewhat less ambitious receiver have asked for suggestions as to how the set under discussion may be "tamed." After a careful study of the technical considerations leading up to the main features of its design, it will be generally agreed that any sweeping alterations to this end are impracticable, and in such cases it seems wisest to recommend an A.C. version of *The Wireless World* Kit Set.

Regulating Screening Grid Voltage.

In the published "List of Parts" the value of the "Truvolt" wire-wound potentiometer (R_2) for controlling screening grid voltage was given as 50,000 ohms. This was used in the original model, but, in the interest of easy adjustment, it was considered advisable to replace this by a value of 25,000 ohms; this appears in the inscription under Fig. 7. Incidentally, the setting of screening grid voltage is fairly critical. This adjustment can be made very accurately with the help of the detector anode milliammeter. The best procedure is to work on strong local signals, with either grid or plate circuits of the H.F. valve detuned to avoid any stray reaction effects. The potentiometer is then adjusted for maximum deflection of the meter, which will indicate that the applied pressure is correct for maximum magnification.

AN IMPORTANT ANNOUNCEMENT.

COMMENCING with the December 4th issue the price of *The Wireless World* is to be 4d. instead of 3d.

This bare announcement is made by our publishers, but we feel that our readers may, quite naturally, expect to be taken a little more into our confidence and be told why it is that we ask them to pay 1d. more for their wireless journal in future.

The reasons for the increase will, we believe, be appreciated with very little explanation by our readers who have watched the rapid developments of wireless both in theory and in practice. The design of a receiver a year or two ago was at the most a matter of two or three weeks' work, the construction was comparatively simple and no great amount of theoretical investigation or measurement was involved. But to-day the position is very different, requirements of modern receiver design necessitating many weeks of careful laboratory measurement and investigation before the finished design is arrived at and the receiver ready to be constructed in *The Wireless World* workshop. The same view must be taken in regard to the preparation of theoretical articles, whilst *The Wireless World* alone amongst its contemporaries conducts a free technical information department for the benefit of its readers. These are all factors which have to be reckoned in the increased cost of production of the paper. If the standard which *The Wireless World* has set itself is to be maintained steadily in the future, and if *The Wireless World* is to continue to be right up to date in everything appertaining to its subject, then we hope our readers will not feel aggrieved when they are asked to contribute a very small individual amount towards the increased expense of production.

The extra 1d. may seem so trifling a sum as to be of no consequence, but, whilst to the individual reader the 1d. is but a small increase, yet to the publishers it means a substantial contribution towards meeting the additional expenditure involved when each 1d. is multiplied by the figure representing the average weekly circulation of the paper.

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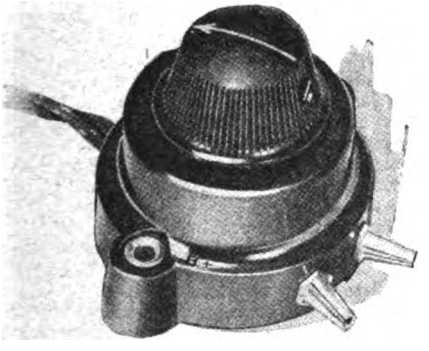
LABORATORY TESTS.

A Review of Manufacturers' Recent Products.

"ELECTRAD" TABLE TONATROL.

This device consists of a variable high resistance connected across output terminals and loud speaker leads. Measurements showed that the resistance was continuously variable from 0 to 23,000 ohms. The contact travels over a wire track consisting of separate loops, each making contact with the resistance element. Wear on the track is practically non-existent, and it should maintain a constant resistance throughout. A flexible two-way cord is provided for attachment to the output terminals on the set, and two small spring contact sockets serve to make connection with the leads from the loud speaker or telephones. These should be finished off with pin terminals of suitable diameter.



"Electrad" table Tonatrol for use with telephones, loud speaker or gramophone pick-up.

The device is of American origin, and is marketed by The Rothermel Corporation, Ltd., 24-26, Maddox Street, Regent Street, London, W.1, at 10s. 6d.

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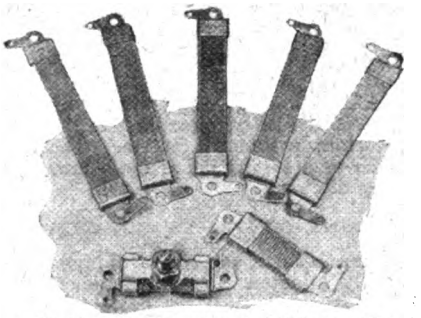
CLAROSTAT "HUMDINGER" AND STRIP RESISTORS.

The "Humdinger" is a potentiometer device with an adjustable centre tap, and has been designed to provide a ready means of obtaining a connection to the electrical centre of the filament, or heater, winding on mains transformers not having a centre-tapped coil. The adjustable moving contact gives a variation in resistance of approximately 60 per cent. either side of the actual centre point. For example, the sample tested was a 200 ohms resistance, nominal and measured, the variable contact giving a change of 62 ohms from the nominal centre to maximum movement in one direction, and 60 ohms change from the centre to the stop in the other direction; this variation being more than sufficient for all practical purposes. These resistances can be employed also as semi-variable potentiometer devices for obtaining "free" grid bias.

"Humdingers" are available in twelve resistance values ranging from 6 to 500 ohms, the price being 4s. in each case.

The fixed resistors are wound on thin strips of insulating material, neatly finished with end caps and provided with fixing holes and soldering tags. These vary in length according to resistance value. They are wire-wound, and available in values of from 1 ohm to 5,000



"Clarostat" wire-wound resistors. The "Humdinger" can be identified by the variable centre tap.

ohms, and a 10,000-ohm unit is in production.

Some samples were measured, and the values found to be very close to the makers' rating.

CLAROSTAT STRIP RESISTORS.

Nominal Value.	Measured Value.	Percentage Error.
1 ohm	1 ohm	—
200 ohms	198 ohms	− 1.0%
1,000 ,,	1,020 ,,	+ 2.0%
1,200 ,,	1,179 ,,	− 1.8%
1,500 ,,	1,580 ,,	+ 5.3%
1,800 ,,	1,840 ,,	+ 2.2%
2,000 ,,	2,020 ,,	+ 1.0%

We understand that prices have not yet been fixed, but particulars can be obtained from Messrs. Claud Lyons, Ltd., 76, Old Hall Street, Liverpool.

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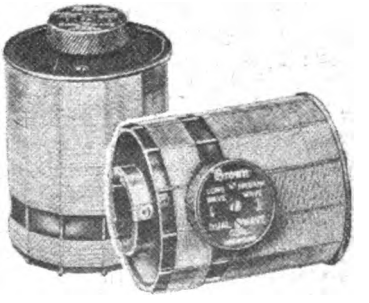
NEW COILS FOR THE BROWN KIT SETS.

It will be recalled that on the last occasion we described the kit sets introduced by the well-known firm of loud speaker manufacturers, S. G. Brown, mention was made that interchangeable coils were fitted. Subsequently, a slight modificaton was made, and all models are now supplied with dual-range coils. These



New dual-wave coils for the Brown kit sets. Change-over switches are carried on the formers.

are wound on formers of the same type as used in the earlier models, the non-reversible base fitting being retained.

It is therefore a simple matter to replace the original coils by the new type, and this can be done without disturbing a single wire in the set. The change-over switches are carried on the coil formers, and, being placed in an accessible position, render change from medium to long waves a relatively simple matter.

The makers, Messrs. S. G. Brown, Ltd., Western Avenue, North Acton, London, W.3, are prepared to exchange the original coils for a set of the new style.

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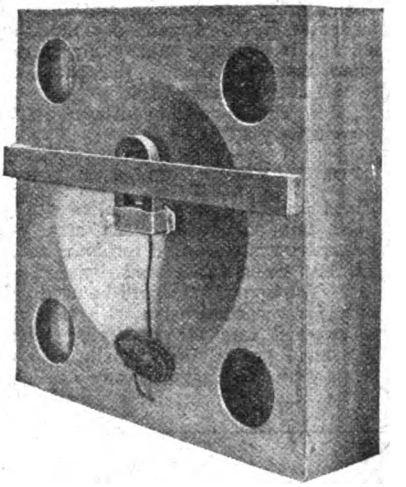
"LINCONE DUPLEX" CHASSIS.

These chassis are supplied by the Bristol Wireless Company (Wholesale), Radio House, Queen's Road, Bristol. Double



Rear view of the "Lincone Duplex" chassis with the unit in position.

cone linen diaphragms are used, these being mounted with their apices adjacent. The movement recommended is a "Blue Spot" unit, type No. 66K, with adjustment.

The chassis sent in for test measured 18in. × 18in. × 5in. deep, the front cone being 16in. in diameter, and the back cone 12in. On test, the response was found to be very good indeed, frequencies from 300 up to 5,200 cycles being well brought out. There was practically no noticeable resonances between these two limits. There was a slight reduction in the output from 4,500 cycles down to 3,000 cycles, but between 3,000 and 300 cycles the normal level was again attained. Below 300 cycles sundry peaks were noticed; however, these were not unduly accentuated, and should not give an artificial base.

The price of this sized chassis is 22s. 6d. and the unit 25s. A larger chassis measuring 24in. × 24in. × 5in. costs 32s. 6d. "Lincone" chassis built into cabinets are available also. The prices of these models are £4 in oak and £4 10s. in mahogany.

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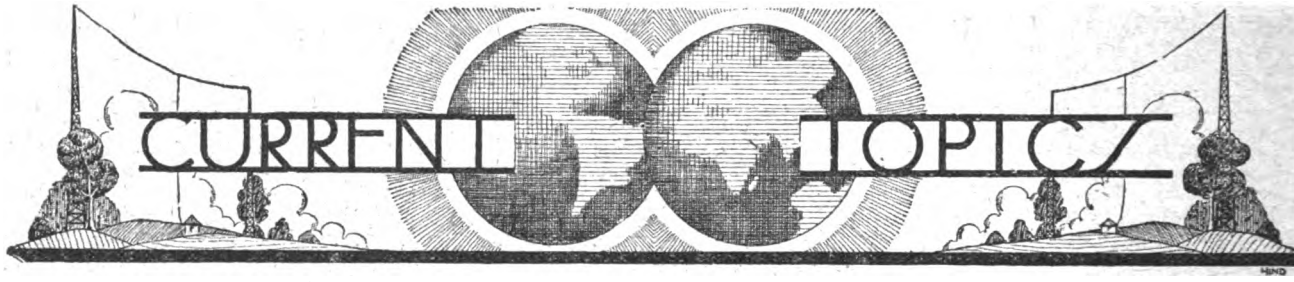

Events of the Week in Brief Review.

WHERE LISTENING IS COMPULSORY.

The Vaud (Swiss) Council of State has made an Order whereby apprentices living beyond a certain distance from a technical school must listen to broadcast courses. Communes affected by the Order are to be provided with Government receiving sets. There will thus be little opportunity to play wireless "truant."

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AMATEUR TRANSMISSION INCREASING.

The French transmitting fraternity, as represented by the Reseau des Emetteurs Français, is rejoicing over a big increase in new members during the past year. The roll now includes 1,100.

British amateur transmitters number approximately 1,800.

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POLICE RADIO NETWORK FOR LONDON?

Plans for equipping all police stations in the London Metropolitan area with wireless transmitters and receivers are, it is stated, being considered by Scotland Yard. The apparatus would be used principally for communication with the wireless-equipped cars of the Flying Squad, which have proved their worth with the limited radio facilities already available.

The scheme provides for a wireless network embracing the whole of the Metropolis with wireless links to the most important provincial centres. The provision of a special police radio branch is being discussed.

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HOME CONSTRUCTORS' SHOW IN MOROCCO.

Morocco's first wireless exhibition, to be strictly limited to the products of amateurs, will open its doors at Casablanca on Saturday next, November 30th. All entrants will be required to make a sworn declaration that the exhibits are home-made. Prizes will be awarded for crystal, straight valve, and superheterodyne sets.

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IRISH RADIO SUCCESS.

The recent Dublin wireless exhibition made a poor start, the attendances being disappointingly low. Before the end of the week, however, public enthusiasm grew to such an extent that the show was transformed into a success, all previous shows being outstripped both in attendance and business transacted.

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OLD AGE PENSIONERS MUST PAY.

In the House of Commons recently the Postmaster-General, Mr. Lees-Smith, said that the Broadcasting Committee of 1925 had considered the question of granting free wireless licences to old age pensioners, but had recommended that this concession should be made to blind persons only. He did not feel justified in asking Parliament to grant any similar concessions to other classes of the community.

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THEORY MADE EASY.

The first five articles on "Wireless Theory Simplified," by S. O. Pearson, B.Sc., which have appeared weekly in *The Wireless World*, were discussed at the last meeting of the Tottenham Wireless Society. General appreciation was expressed regarding the usefulness of the articles, and it has been decided to make them the basis of discussion at future meetings.

The series is proving of special value to many experimenters and constructors who have little opportunity to study wireless theory as presented in the average text-book. A useful aid towards deriving the maximum value from the articles is Mr. S. O. Pearson's "Dictionary of Wireless Technical Terms," which was first published in weekly instalments in *The Wireless World*, and is now obtainable in pocket-book form at 2s., or post free from our publishers at 2s. 2d.

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NAVAL WIRELESS TELEGRAPHY.

At a meeting of the Wireless Section of the Institution of Electrical Engineers on Wednesday next, December 4th, at the Institution, Savoy Place, W.C.2, a paper will be read on "Naval Wireless Telegraphy Communications." The authors are Mr. G. Shearing, B.Sc., and Capt. J. W. S. Dorling, R.N.

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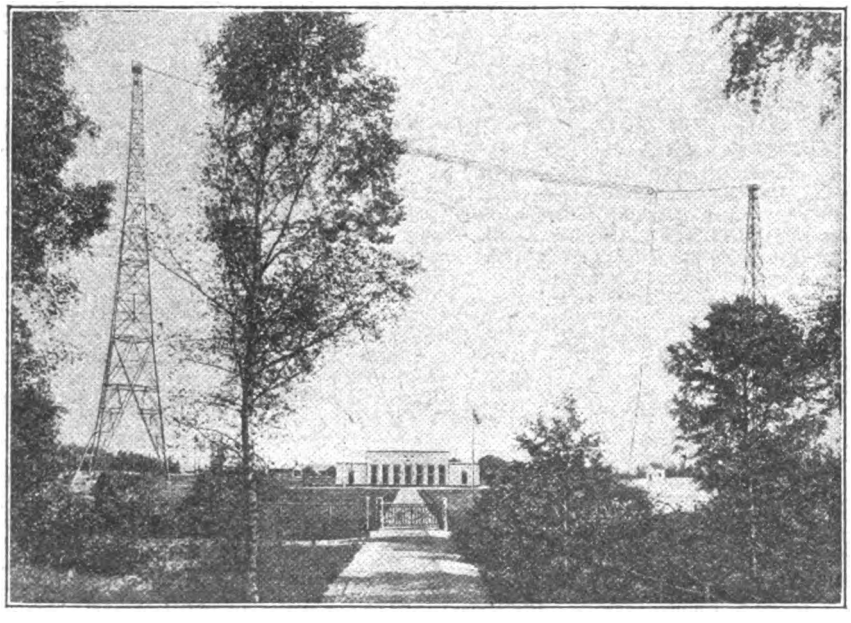
BROADCASTING BATTLE IN FRANCE.

Two rival schools of thought produced a checkmate at the French National Broadcasting Congress, which met in Paris on November 14th, 15th and 16th, with the object of influencing the coming legislation for establishing broadcasting on a new basis.

The public debates were marked by lively skirmishes, writes our Paris correspondent, the outcome being the dignified withdrawal of the minority party, which stands for State control. Those who remained to continue the discussion were divided into two groups, both striving for "controlled liberty," but each giving the term a different meaning. One faction, representing the trade, would like the present Bill passed in its entirety, as safeguarding national interests through the ministrations of a National Broadcast



SWEDEN'S "DAVENTRY."—A picturesque glimpse of the 30kW. broadcasting station at Motala, which distributes the Stockholm programme over the greater part of Sweden on a wavelength of 1,345 metres.

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Bureau similar to the B.B.C. The partisans of the alternative scheme of "controlled liberty" aim at a National Bureau, the members of which would not be nominated by the Government, but elected by popular vote, representing various public authorities, intellectual and manual workers, trades unions and similar bodies.

It is doubtful whether this unsatisfactory gathering will influence subsequent events. The only point on which unanimity was reached was that the present broadcasting position is "lamentable."

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CREATING WANDERLUST BY WIRELESS.

A mobile short-wave transmitter was used in a new experiment made on Sunday last by the French "Office National de Tourisme" in an endeavour to stimulate touring. A representative of the organisation motored through several delectable districts of "La Belle France" and at a preconcerted time set his short-wave transmitter in operation and broadcast an alluring account of the places he had visited. The transmission was picked up on a receiver on the outskirts of Paris and relayed to Paris PTT.

The test was a precursor of a special series to be started early in 1930.

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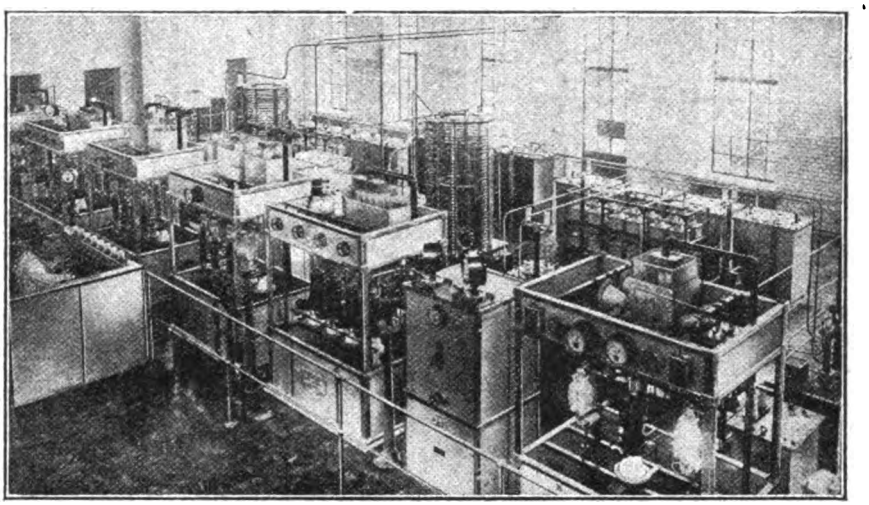
RADIO SOCIETY'S £350 HOSPITAL GIFT.

When the Duchess of York visited Southend on November 12th to lay the foundation stone of Southend's new £200,000 hospital and to receive purses of donations for the funds, the Southend and District Radio Society presented a purse containing an undertaking to equip the hospital throughout with wireless at an estimated cost of £350. In addition, a second purse was given containing nearly £5, the proceeds of a collection at a recent meeting of the society.

It is of interest to recall that the society equipped the present hospital of hundred beds at a cost of over £120 and maintains the whole installation free of all cost and responsibility to the authorities. Every bed has its pair of telephones, and the children's wards and staff sitting-rooms all have loud speakers—eight in all.



MOTALA'S BRITISH-MADE TRANSMITTER. The transmitting hall of Sweden's high-power station. The equipment was manufactured by the British Marconi Company at Chelmsford.

"CRYSTAL GLOBE" RECEPTION.

A "crystal globe" moving picture receiver which picks up wireless film transmissions and simultaneously projects the pictures on a screen is described by the Washington correspondent of *The Daily Telegraph*. The inventor, Dr. Vladimir Zworykin, research engineer for the Westinghouse Electric Company, employs a cathode-ray valve which takes the place of the normal glow valve, scanning disc and motor. The valve is cone-shaped with a flat end upon which the transmitted picture appears.

SHORT-WAVE BROADCASTING STATIONS OF THE WORLD.

Arranged in Order of Wavelength and with Usual Times of Transmission.

Station.	Frequency in Kilocycles.	Wavelength in Metres.	Kilowatts in Aerial.	Times of Transmission (G.M.T.).
Motala, Sweden	3,033	98.9	—	Stockholm Programme
7RL, Copenhagen ("Popular Radio" Experimental).	3,561	82.24	—	Mon., Fri. 23.00
8KR, Constantine, Algeria.	3,750	80	—	Mon., Fri.
OHK2, Vienna	4,285	70	—	Sun. 17.00
AFK, Döbintz, Germany .	4,434	67.65	5	Mon., Wed., Fri. 10.00 and 18.00
W8XF, Cleveland, Ohio (short-wave of WHK) ..	4,550	66.04	0.5	—
W2XBA, Newark, N.J. (short-wave of WAAM).	4,603	65.18	0.5	—
W8XK, East Pittsburg, Pa. (short-wave of KDKA)..	4,800	62.5	—	—
Paris, Radio LL	4,918	61	—	12.30
Khabarovsk, Russia	4,990	60.12	20	—
Pragua, Czechoslovakia ...	5,172	58	—	—
AGJ, Nauen, Germany (occasionally)	5,291	56.7	—	—
Rugles, Eure France (Journal des 8)	5,455	55	—	22.00
AFL, Bergedorf, Germany.	5,769	52	3	—
AIN, Casablanca, Morocco	5,882	51	—	—
EAJ25, Barcelona (Radio Club), Spain	6,000	50	—	Sat. 16.00.
RFN, Moscow.....	6,000	50	—	Tues., Th., Sat. 12.00
W2XBR, New York (R.C.A.) (short-wave of WBNY).	6,020	49.83	1	—
W9XF, Downer's Grove, Ill. (Gt. Lakes Radio Broadcasting Co.)	6,020	49.83	5	—
W2XAL, Çoytesville, N.J. (short-wave of WRNY, Experimenter Pub. Co.)	6,040	49.67	0.5	—
W8XAL, Harrison, Ohio (short-wave of WLW and NBC Crosley Radio Corporation).....	6,060	49.5	0.25	00.00 (Ex. Fri. and Sat.)
W9XU, Council Bluffs, Iowa (short-wave of KOIL) ..	6,060	49.5	0.5	—
W3XAU, Philadelphia, Pa.	6,060	49.5	0.5	—

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Station.	Frequency in Kilocycles.	Wavelength in Metres.	Kilowatts in Aerial.	Times of Transmission (G.M.T.).
UOR2, Vienna	6,072	49.4	0.4	—
W2XCX, Kearney, N.J. (short-wave of WOR)	6,080	49.34	0.5	—
W9XAA, Chicago, Ill. (Federation of Labour)	6,080	49.34	0.5	—
W8XAL, Westminster, Cal. (Pacific-Western Broadcasting Federation)	6,080	49.34	15	—
W3XAL, Bound Brook, N.J. (R.C.A.)	6,100	49.18	20	—
W2XE, Richmond Hill, N.Y. (Atlantic Broadcasting Corporation, short-wave of WABC)	6,120	49.02	5	23.00
W8XK, Pittsburg, Pa. (Westinghouse Electric).	6,140	48.86	20	—
I1AX, Rome (Via Savoia 80)	6,667	45	—	--
X051, San Lazaro, Mexico.	6,818	44	—	07.00 and 19.00
D4AFF, Coethen, Germany	6,881	43.6	—	--
1MA, Rome	6,896	43.5	—	Sun. 16.00
EAR110, Madrid (Assoc. Nee de Radio-eschucas).	6,977	43	—	—
6AG, Perth, West Australia	7,142	42	—	10.30 and 15.00
Paris (Radio Vitus)	7,316	41	—	19.30
YR, Lyons	7,463	40.2	—	16.30
DOA, Döberitz, Germany	7,500	40	—	17.00
PCL, Kootwijk, Holland (League of Nations' Services to America)	7,730	38.8	25	15.00
JHBB, Ibarakiken, Japan.	8,000	37.5	--	--
EATH, Vienna	8,108	37	--	--
HS4PJ, Bangkok, Siam	8,108	37	0.2	Tues. and Fri. 13 00 and 18.00
W2XAC; Schenectady, N.Y. (G.E.C.)	8,696	34.5	—	—
2BL, Sydney	9,230	32.5	—	—
FLJ, Issy-les-Moulineaux, Paris (Time Signals)	9,230	32.5	7	07.56 and 19.56
HB9OC, Berne, Switzerland	9,375	32	--	—
D7MK, Copenhagen (" Radioposten ").	9,380	32.05	—	Tu. and Fri., 23.00
Posen, Poland	9,434	31.8	0.25	18.20
Paris (Exper.)	9,479	31.65	2	21.00
Lyngby, Denmark	9,494	31.6	1	18.00
3LO, Melbourne, Australia (temporarily closed)	9,503	31.55	—	—
W9XA, Denver, Colorado (short-wave of KOA, G.E. Co.)	9,530	31.48	0.75	—
W2XAF, Schenectady, N.Y. (short-wave of WGY, G.E. Co.)	9,530	31.48	40	23.00
PCJ, Eindhoven, Holland (Philips Lamp Works, Transmitter at Hilversum)	9,554	31.4	25	Thurs., Fri. 19.00 Sat. 02.00
Zuesen, Germany	9,560	31.38	—	19.00
W3XAL, Bound Brook, N.J. (R.C.A.)	9,570	31.35	20	—
W8XK, East Pittsburg, Pa. (Westinghouse Electric)	9,570	31.35	20	—
2FC, Sydney, Australia	9,590	31.28	—	—
LGN, Bergen, Norway	9,600	31.25	—	--
7LO, Nairobi, Kenya Colony	9,677	31	—	16.00
W2XAL, New York (short-wave of WRNY, Experimenter Publishing Co.)	9,700	30.91	0.5	00.00
Agen, France	9,756	30.75	—	Tu. and Fri. 21.00
GRJX, Winnipeg, Canada	11,718	25.6	2	22.30
W3XAL, Bound Brook, N.J. (R.C.A.)	11,720	25.6	20	—
5SW, Chelmsford (B.B.C. Experimental)	11,751	25.53	15	12.30 and 19.00 (Ex. Sat. and Sun.)
W9XF, Downer's Grove, Ill. (Gt. Lakes Radio Broadcasting Co.)	11,800	25.42	5	—
W9XAA, Chicago, Ill. (Federation of Labour)	11,840	25.36	0.5	—
W8XK, Pittsburg, Pa. (Westinghouse Electric, relays KDKA)	11,880	25.25	20	—
Oporto, Portugal (Apollo Theatre, Exp.).	12,000	25	—	12.00, 19.00 and 22.00
K1XR, Manila, Philippine Islands	12,240	24.5	—	18.30
W6XN, Oakland, Calif. (Short-wave of KGO, G.E. Co.)	12,850	23.35	5	17.30
W2XO, Schenectady, N.Y. (Short-wave of WGY, G.E. Co.).	12,850	23.35	—	Tues., Thurs., Sat. 17.00
Vienna (Ravag)	13,513	22.2	0.24	—
W3XAL, Bound Brook, N.J. (R.C.A.)	15,130	19.83	20	—
W8XK, Pittsburg, Pa. (Westinghouse Electric).	15,210	19.71	20	—
W6XAL, Westminster, Calif. (Pacific Western Broadcasting Federation)	15,250	19.67	15	—
W2XAD, Schenectady, N.Y. (G.E. Co., short-wave of WGY)	15,340	19.56	25	17.00
Lyngby, Denmark (Exper.) (Power will be increased to 10 kW.)	15,789	19.6	1	—
PCL, Kootwijk, Holland (League of Nations' Services before 3.0 p.m.)	16,304	18.4	25	11.00
W2XK, Schenectady, N.Y. (G.E. Co., short-wave of WGY).	17,300	17.31	25	Tues., Thurs., Fri. 17.00
AGC, Nauen, Germany	17,441	17.2	—	—
HS1PJ, Bangkok, Siam	17,751	16.9	20	Sun. 12.00 and 18.00
PHI, Huizen, Holland	17,769	16.88	40	15.00
W9XAA, Chicago, Ill. (Federation of Labour)	17,780	16.87	0.5	—
W3XAL, Bound Brook, N.J. (R.C.A.)	17,780	16.87	20	—
PLF, Bandoeng (Malabar), Java	17,850	16.8	30	13.00
PCK, Kootwijk, Holland	18,404	16.3	—	06.00
PLE, Bandoeng, Java	18,820	15.94	—	12.40
Nancy, France	19,351	15.5	—	21.00
Buenos Aires	19,973	15.02	—	--
W9XF, Downer's Grove, Ill. (Gt. Lakes Radio Broadcasting Co.)	21,500	13.95	5	—
W6XAL, Westminster, Calif. (Pacific Western Broadcasting Federation)	21,500	13.95	15	—
W3XAL, Bound Brook, N.J. (R.C.A.)	21,500	13.95	20	—
W8XK, Pittsburg, Pa. (Westinghouse Electric).	21,540	13.93	20	—

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By Our Special Correspondent.

The Silent Carrier.—A Breakdown.—European Relay Network.

Warming-up the Twin Transmitter.

Wordless whispers are already issuing from the twin transmitter at Brookmans Park, which is now sending out an unmodulated carrier wave every evening from seven o'clock till eleven on its allotted wavelength of 261.3 metres. I understand that comparatively low power is being used, certainly not more than 5 kilowatts.

oooo

Interlopers Not Wanted.

Since no real testing is being carried out, one may well ask why Tweedledee is wasting its fragrance on the desert air. I can suggest a probable explanation. Owing to the limitations of the Prague Plan there are a number of foreign transmitters wandering forlornly up and down the wavelength scale in search of a vacant spot. The wavelength of 261.3 metres has been granted exclusively to Britain, but a homeless foreigner, finding that wavelength out of use, would probably acquire and hold it on the principle that possession is nine points of the law. Whether or not this explains the silent transmission, the B.B.C. would do well to keep it going until the tests begin.

oooo

Brookmans Park Breaks Down.

Meanwhile it is my sad duty to record the first breakdown at Brookmans Park. This occurred on November 18th, 1929, at 1.52 p.m., when a burnt-out meter stopped transmission for three minutes. How many listeners noticed the break?

oooo

"Bed Sit" Sufferers.

Visits to the homes of listeners who have complained of inability to hear Brookmans Park on a crystal set have convinced the B.B.C. engineers that the greatest sufferers under the new regime are dwellers in bed sitting-rooms, the majority of these being unable to erect an outside aerial or to afford anything more expensive than a crystal set.

oooo

Retailers and Aerials.

Other crystal users with facilities for erecting outside aerials have been subjected to a new form of victimisation by the less reputable members of the wireless trade. In these cases the retailer has refused to erect an outside aerial unless the customer agrees to purchase a valve set, the excuse being that a crystal set will be useless even with the new aerial.

The crystal user may well question the value of an outside aerial!

oooo

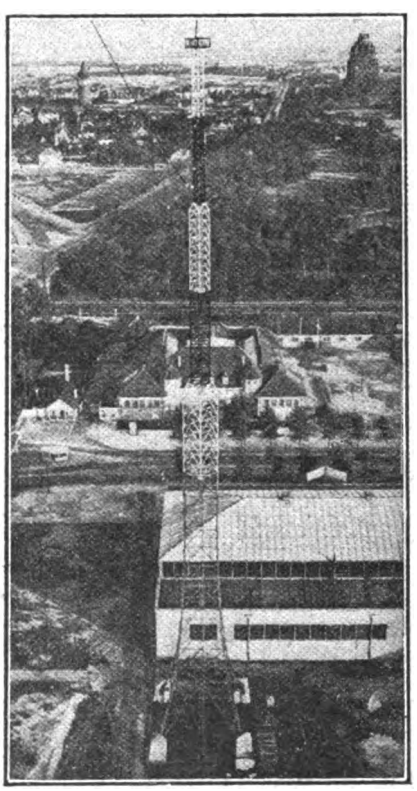
From the Savoy Hill Post Bag.

"Brookmans Park is said to be a wipe out. It is a wash out."

oooo

Relaying from the Continent.

The relay of Strauss's "Salome" from Cologne on Friday next must not be associated with the special relay tests to which reference was made in these columns last week. The experiments beginning in January next will employ for the first time a new set of trans-Continental land lines which are under test by the German Post Office.



LEIPZIG.—An impressive view of the southern mast photographed from the top of its neighbour. In the right background is the Leipzig War Memorial.

oooo

A European Network?

The aspirations of the long-distance listener are certainly not being considered by the B.B.C. or any other European broadcasting authority; on the other hand, ambitious schemes are afoot for the development of a European network of relays not unlike the "Red" and "Blue" networks in America. Broadcasting organisations on both sides of the Channel are now casting fond eyes on the project for a new Anglo-Belgian cable to be completed in two or three years' time. This cable will embody the latest improvements in amplifiers and repeaters, so that we may hope that the time will come when a landline broadcast will give us a reasonable band of musical frequencies.

oooo

Neck to Neck.

In a recent issue it was stated that the increase in the number of licensed German listeners in the last quarter amounted to 16,941. According to an official at Savoy Hill, the increase in British licencees during the same period amounted to 17,025.

oooo

Radio Week in Bristol.

Bristol Radio Week will be held from December 8th to 14th. On the first day Sir Thomas Beecham conducts the National Orchestra of Wales, the concert being relayed to 5WA from Park Hall, Cardiff.

A Sailors' and Soldiers' Night, arranged in conjunction with the British Legion, will be relayed from Colston Hall on December 9th.

On December 12th "Smooth Crossing," a new play in one act by Mr. Froom Taylor, will be presented by Bristol's Little Theatre Company, and relayed to the Cardiff station.

Mr. Winston Churchill will be installed as Chancellor of Bristol University on December 13th. It is expected that his address will be relayed to Daventry 5XX as well as to Cardiff.

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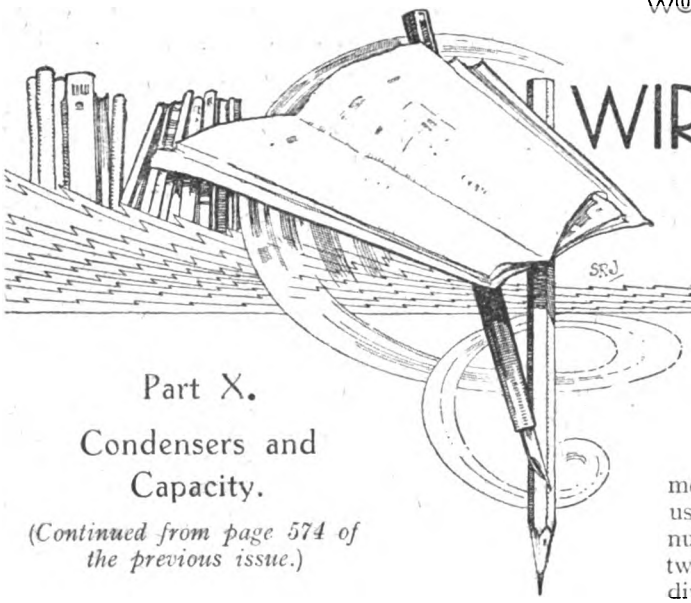

WIRELESS THEORY SIMPLIFIED

Part X.

Condensers and Capacity.

(*Continued from page 574 of the previous issue.*)

By S. O. PEARSON, B.Sc., A.M.I.E.E.

NOW that the fundamental principle of condenser action has been described the various factors upon which the value of the capacity depends must be enumerated. If the two parallel plates A and B, representing the elementary condenser discussed in the previous issue (Part IX), and illustrated there in Fig. 1, are brought closer together, it will be found that the capacity is increased. In reducing the distance between the plates the length of the electrostatic lines of force has been shortened. The result is that a given potential difference between the plates is capable of driving more lines of force across the shortened gap in much the same way that a battery will drive more current through a resistance wire if the latter is shortened. The electrostatic field has been *condensed* into a smaller space and intensified, resulting in increased capacity. Hence the name "condenser."

By discharging a simple parallel plate condenser through a suitable galvanometer it can be shown that the momentary deflection is inversely proportional to the distance between the plates, assuming the same initial voltage between them in every case. This is only true provided the distance between the plates is small compared with their dimensions, because if they are far apart the lines of force will spread out at the edges and so upset the inverse proportionality. We see, then, that the capacity varies inversely as the distance between the plates when they are moderately close together.

Now since the capacity is evidently proportional to the number of electrostatic lines crossing from one plate to the other for a given potential difference, it is fairly obvious that the capacity can also be raised by increasing the area of the *opposed surfaces* of the plates, in the same way that the current given by a battery can be raised by substituting a wire connected between its terminals by another of larger cross-sectional area.

We see, then, that the capacity of a condenser with air as the medium between the plates can be altered either by changing the distance between the plates or by varying the effective area of opposed surfaces. For mechanical reasons an ordinary variable air condenser as used for tuning purposes employs the latter principle. A number of interleaved small plates are used instead of two large ones, also for mechanical reasons. They are divided into two groups insulated from each other, one fixed and the other movable at will, and the movable ones can be shaped to give any desired relationship between angle of rotation and capacity, e.g., square law, straight line frequency, etc.

Effect of the Dielectric on the Capacity.

There is yet another very important factor upon which the capacity of a condenser depends besides the dimensions of the plates and their relative positions, and that is the nature of the dielectric between the plates. Most solid insulating materials allow lines of electrostatic force to pass through them much more easily than air or a vacuum. Therefore, if a condenser with air as the insulating medium between the plates has the air replaced by some solid insulating material, or *dielectric* as it is called, the number of lines passing between the plates for a given potential difference will be increased, with consequent rise in the capacity. For instance, if a condenser with air dielectric has the air replaced by mica the capacity will be increased about six times. The number of times by which the capacity is increased when the air is replaced by some other medium is called the *permitivity* or *dielectric constant* of the new medium. Strictly speaking, the comparison should be made with a vacuum, but as air has a permitivity very nearly equal to 1, the above statement is sufficiently accurate for our purpose and is more practical. An older name for permitivity was "specific inductive capacity."

Mica has a permitivity of about 6, depending on its quality. It is extremely interesting to note that ice at a temperature of -13.5° Centigrade has the enormously high permitivity of 22,000!

Fixed Condensers of Large Capacity.

Although it is not a very practicable proposition to use a solid dielectric for condensers where the capacity is to be continuously variable, a solid dielectric is almost always employed in condensers of fixed capacity. For small fixed condensers mica is usually employed between two sets of interleaved sheets of tinfoil or copper-foil. In condensers of large capacity, however,

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Wireless Theory Simplified.—

say from half a microfarad upwards, the dielectric usually consists of a special kind of paper. A long strip of the paper is coated on both sides with a conducting material by a special process, the best known being the Mansbridge process. A margin of uncoated paper is left at each edge. The strip is then rolled up so as to occupy a suitably small space and enclosed in a container, one terminal being connected to each coating.

Obviously it is most important that the dielectric used should be a really good insulator, otherwise the charge will " leak " from one set of plates to the other through the dielectric, and the condenser would behave as though it were shunted by a resistance of high value. Air is the best in this respect (except, of course, an absolute vacuum), and among solid dielectrics mica is one of the best. Mica has the further advantage that it can stand a much higher voltage across a given thickness without breaking down compared with most other materials. Air insulation is broken down by high voltages much more easily than most solid dielectrics.

If two or more condensers are connected in parallel as shown in Fig. 1, the resultant capacity C will be simply equal to the sum of the individual capacities, because the effect is exactly the same as increasing the area of opposed surfaces. For the group of Fig. 1, then, we have $C = C_1 + C_2 + C_3$. Note that this is the same law as for resistances in *series*.

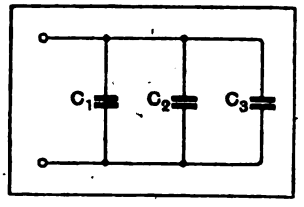

Fig. 1.—For condensers in series the total capacity is equal to the sum of the individual capacities.

When condensers are connected in series the resultant capacity is found by applying the same rule as for resistances in *parallel*. For instance, if we connect three condensers whose capacities are C_1, C_2 and C_3 in series, as shown in Fig. 2, the resultant capacity is given by $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$.

The reason for this follows from the fact that in charging a single condenser, the quantity of electricity gained by one plate is exactly equal to that lost by the other. The same law applies to the series arrangement, so that equal charges must move from plate to plate throughout the series; in other words, each condenser will be given the same charge, Q, irrespective of its size. But the voltage across each will not be the same, being inversely proportional to the capacity for a given charge. Thus, if the voltages across the three condensers of Fig. 2 are V_1, V_2 and V_3 respectively when the charge of each is Q coulombs, the total voltage between the end of the series will be $V = V_1 + V_2 + V_3$. But from the definition of capacity $V_1 = \frac{Q}{C_1}$, $V_2 = \frac{Q}{C_2}$, $V_3 = \frac{Q}{C_3}$, and $V = \frac{Q}{C}$, where C is the resultant capacity.

Hence $\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$, or $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$.

From this it is clear that the resultant capacity must be less than that of the smallest condenser in the series.

The Energy Stored in a Condenser.

It was shown previously that when a condenser is charged—that is, when a potential difference is applied between the plates—energy is stored in the electric field between them. Just as energy was found to be necessary to build up a magnetic field, so energy is required to build up an electrostatic field, no matter whether the field is produced in a vacuum, in air, or in any other dielectric, solid or liquid.

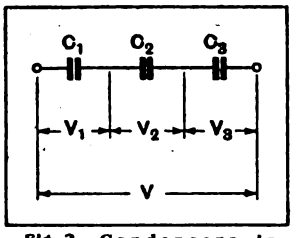

Fig. 2.—Condensers in series. The resultant capacity is given by $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

It is a very simple matter to determine the amount of this energy in terms of the capacity of the condenser and the voltage between the plates. As explained in the previous part, suppose that the charging current is maintained at a constant value of I amperes during the charging period by reducing the series resistance in the circuit at a uniform rate from the initial value to zero during this time. Then, since the electrons are being transferred from one set of plates to the other at a steady rate, the voltage across the condenser will build up at a uniform rate. Suppose further that the charging period lasts for *t* seconds. These conditions are shown by the graphs of Fig. 3.

It is clear that the *average* value of the voltage across the condenser during the charging period will be $\frac{1}{2}E$ volts, and in driving the current I against this opposing voltage an average power of $\frac{1}{2}EI$ watts will be expended on the condenser for *t* seconds. The energy consumed in charging it is equal to the product of average power and time exactly as in the case of the inductive coil, and so the energy required to build up the electric field will be $\frac{1}{2}EI \times t$ watt-seconds or joules. But the product of current and time is the quantity of electricity or " charge " Q coulombs which has been transferred. Hence the stored energy = $\frac{1}{2}EQ$ joules.

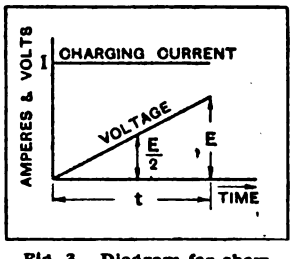

Fig. 3.—Diagram for showing that the energy stored in a condenser is given by $\frac{1}{2}CE^2$, where C is the capacity and E the voltage.

Now the capacity of the condenser was defined as the quantity of electricity required to produce a change of one volt between the plates; in other words $C = \frac{Q}{E}$ farads (see previous part), whence $Q = CE$. Substituting this value of Q in the expression for stored energy above, we get

stored energy $W = \frac{1}{2}CE^2$ joules.

It should be noted that the expression is of the same form as $\frac{1}{2}LI^2$ for the energy stored in a magnetic field. The latter gives the energy in a field due to electrons in motion (current), whereas the former relates to the kind of field produced by electrons at rest but under the influence of an electrical pressure or voltage.

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Wireless Theory Simplified.—

The action of a condenser can be likened to that of a spring in mechanics. Suppose that we take an ordinary spiral or helical spring and suspend it by one end from a rigid support so that it hangs vertically downwards. If now a gradually increasing force is applied to the lower end so as to extend it downwards, then, by a very well-known law of mechanics, the extension will be exactly proportional to the applied force. Let F be the force required to extend (or compress) the spring through a distance D (we need not concern ourselves with the units. Then $\frac{F}{D}$ is the force required to produce unit extension of the spring, and this value may be called elasticity or stiffness of the spring. It should be realised that elasticity means the extent to which a body *resists* bending or distortion of any kind or the extent to which it resists compression.

Let S denote the stiffness of the spring, so that $S=\frac{F}{D}$ whence $D=\frac{F}{S}$; or, in words, the displacement is proportional to the applied force and inversely proportional to the stiffness.

As the spring is extended the applied force increases from zero in direct proportion to the displacement until it reaches the value F, when the extension is D. Thus the average value of the force is $\frac{1}{2}F$. Now, in mechanics, work done or energy consumed is equal to the product of the force acting and the distance through which it acts; so the work done in extending the spring will be $\frac{1}{2}F \times D$, and substituting for D the value $\frac{F}{S}$ found above we get: energy stored in spring $=\frac{1}{2}F \times \frac{F}{S}=\frac{1}{2}\left(\frac{1}{S}\right)F^2$.

Comparing this expression with that for the energy contained in a charged condenser, namely $\frac{1}{2}CE^2$, we see at once that they are alike in form, only the symbols used being different. F stands for the mechanical force and E for the electromotive force; in the formula for the spring $\frac{1}{S}$ takes the place of the capacity C of the condenser, or, by inverting each of these, we can say that $\frac{1}{S}$ in the one case corresponds to S in the other. Putting this into words, it means that *the reciprocal of the capacity of the condenser corresponds to the stiffness of a spring*. The stiffer the spring the smaller will be the deflection and the smaller the energy stored in it for a given applied force; the *lower* the capacity of the condenser the smaller the amount of energy stored for a given electromotive force.

In case any reader should consider this rather detailed comparison between a condenser and a spring unnecessarily long and tedious, it should be explained here that this has been done purposely in preparation for further discussion relating to oscillating circuits. Inductance has already been likened to inertia or mass, and both of these analogies will be made full use of later.

Magnetic and electric fields are produced in the ether and are modified by the presence of certain materials. They are, however, of fundamentally different natures—it may be said that inductance is to the ether what mass is to material, and the reciprocal of capacity is to ether what elasticity or stiffness is to material.

(*To be continued.*)

Transmitting with Low Power.

The problems of radio transmission from the amateur's point of view were dealt with in a lecture given by Mr. L. C. Holton at the last meeting of the North Middlesex Radio Society. Mr. Holton began by emmerating the desirable features of an amateur 10-watt transmitter. These were flexibility of wavelength, transportability, and accuracy of adjustment. These remarks were illustrated by the Society's portable transmitter, which was described as very nearly ideal for small power. On larger powers, however, slightly more robust components are desirable, and a description was given of the speaker's proposed new installation, the skeleton of which was exhibited.

Hon. Secretary, Mr. E. H. Laiser, 7a, Station Road, N.21.

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High Impedance or Low?

"My Ideal Resistance Capacity Coupled L.F. Amplifier" was the title of an address given by Mr. C. N. Fairweather at the last meeting of the South Croydon and District Radio Society. The speaker asked what should be the correct valve for a resistance capacity coupled amplifier, a question which was answered in more ways than one and proved a subject for debate. A strong section of the meeting maintained that one of a very high impedance was essential. With this valve having an amplification factor of as much as 30 or 40 the final amplification would be considerable, and as such was thought to be an advantage. A stronger section of the meeting, however, insisted that a high-magnification valve was completely wrong in every respect. The protagonists of this point of view used the blackboard to demonstrate that a valve of this type would play havoc with the cherished high notes.

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

CLUB NEWS.

Power from the D.C. Mains.

Owing to the fact that Muswell Hill and District Radio Society has D.C. mains it is a matter of difficulty economically to obtain both H.T. *and* L.T. from the electric supply. Mr. L. Hartley, B.Sc., A.I.C., however, gave some useful information at a recent meeting of the Society as to the best means of overcoming this problem. A high-power amplifier driving a moving-coil speaker was demonstrated, and, despite the fact that all current was derived from the D.C. mains, practically no hum could be heard either with or without speech or music. The wattage consumption, too, was commendably low. Particular emphasis was laid on the need for an efficient smoothing circuit, as the local mains are notorious for their very pronounced ripple.

Hon. Secretary, Mr. C. J. Witt, 38, Coniston Road, N.10.

FORTHCOMING EVENTS.

WEDNESDAY, NOVEMBER 27th.

Muswell Hill and District Radio Society.—At 8 p.m. At Tollington School, Tetherdown, N.10. Lecture and demonstration: "Mains-operated Receivers," by Mr. A. J. Hall, of Philips Lamps, Ltd.

Queen's Park Radio Society.—At 8 p.m. At The Oddfellows' Hall, 593, Harrow Rd., W.10. Lecture: "H.F. Amplifiers; with Special Reference to Peaked Amplifiers for the Regional Scheme."

Edinburgh and District Radio Society.—Lecture: "Photo Electric and Selenium Cells," by Dr. Childs.

THURSDAY, NOVEMBER 28th.

Slade Radio (Birmingham).—At the Parochial Hall, Broomfield Rd., Erdington. Annual General Meeting.

TUESDAY, DECEMBER 3rd.

Ryde Radio Society.—At 8 p.m. At Mount House Hall, George St. Lecture and demonstration by Mr. R. Garside (of Messrs. Ferranti, Ltd.).

The Television Society.—At 8 p.m. At the Engineers' Club, Coventry St., London, W. Lecture (with lantern slides): "The Problem of Synchronisation in Picture-Telegraphy and Television," by Mr. G. Prichentard. (Non-members' tickets obtainable from the Secretary, 4, Duke St., Adelphi, W.C.2.).

New Headquarters.

The Queen's Park Radio Society has now changed its place of meeting to the Oddfellows' Hall, 593, Harrow Rd., Paddington. Meetings are held regularly on Wednesdays at 8 p.m., and visitors are cordially invited. The winter programme includes many attractive items. Hon. Secretary, Mr. H. F. Murfett, 12, St. John's Road, Wembley.

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Screened Grid Operation Explained.

In a lecture at the last meeting of Slade Radio (Birmingham), Mr. N. B. Simmonds aroused special interest by discussing the H.F. and detector stages of the Society's screened grid receiver. Valve characteristics and all details of the circuit were fully explained in a manner which prompted members to incorporate a screened grid stage in their own sets. The annual general meeting of the Society will be held on Wednesday, November 27th, when it is hoped that all members will be present. Full details of the Society may be obtained from the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

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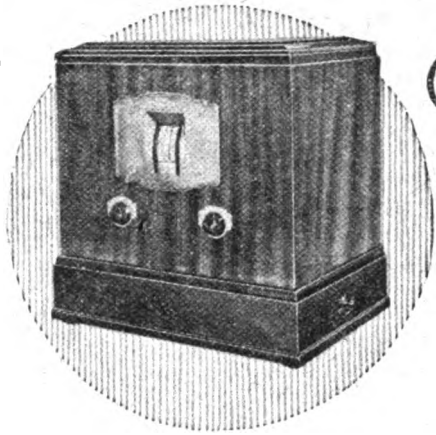
BROADCAST RECEIVERS

A Selective Long-Range Receiver



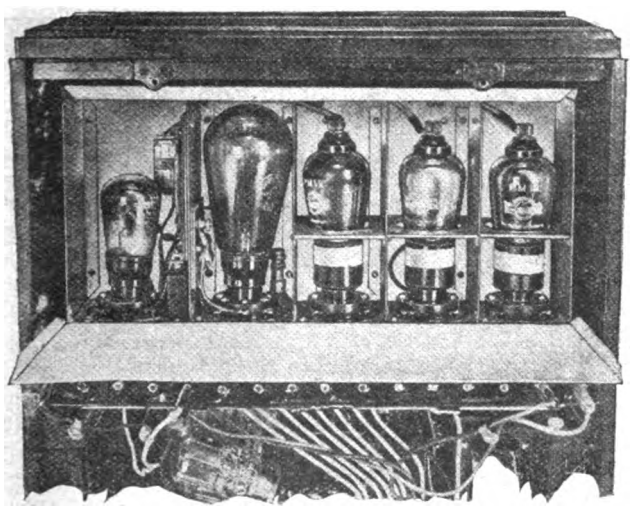
Columbia

ALL ELECTRIC MODEL 304

Representative of Modern Practice.

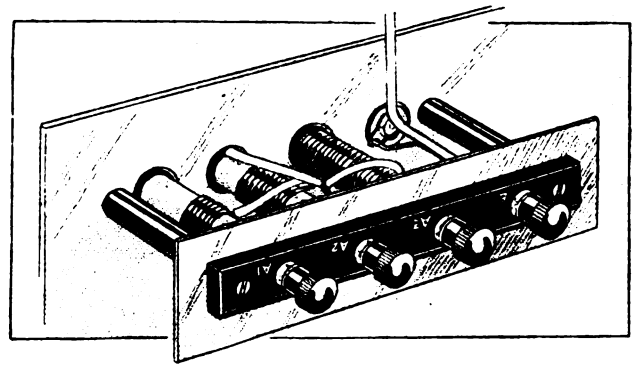
THE entry of the Columbia Graphophone Co., Ltd., into the radio industry was an event of considerable importance, and the receivers exhibited at Olympia were the subject of much discussion and favourable comment. We have now had an opportunity of testing one of the No. 304 table models, and the results are fully in keeping with the efficient appearance of the layout. There can be no doubt that Columbia sets bear all the marks of the thoroughbred, and the 1930 models can definitely be placed among the best half-dozen makes at present on the market.

Although three distinct types are available for operation from batteries, A.C. or D.C. mains, the receiver section is the same in each case and is housed in an aluminium screening box occupying the upper half of the cabinet, the space below being devoted to rectifying and smoothing gear. Valves with directly heated filaments have been standardised throughout, and although this somewhat complicates the problem of filament supply from A.C., the advantages from the production point of view are obvious. The standardised receiver chassis can be manufactured on mass-production lines and then taken from store and equipped either with battery, A.C. or D.C. mains supply according to fluctuations in the demand.



Interior view of valve compartments; the three right-hand compartments house the H.F. valves, while the detector is on the extreme left.

The screening box is well designed both from the electrical and maintenance point of view. The valves which, incidentally, are selected and graded by the makers, are isolated in separate cubicles at the back of the box, to which access is gained by lifting a top lid and dropping the hinged back. Horizontal screens are fitted in the three H.F. valve compartments to prevent electrostatic coupling between the grid and anode circuits, while the leads to the anode terminals at the top are, for a similar reason, shrouded in spiral wire armouring. While the aluminium screening looks after stray electrostatic couplings, magnetic coupling is minimised by the use of binocular or astatic inductances throughout.



Aerial terminal strip and wire-wound series condensers.

The aerial may be connected to three alternative terminals provided with series condensers of graduated capacity.

Ganged H.F. Circuits.

There are three stages of H.F. amplification, with screen-grid valves and transformer coupling. By distributing the H.F. amplification over three stages a high overall figure is obtained without any tendency to instability in individual stages. Further, the overall selectivity can be made very high without appreciably cutting side bands and the higher audio-frequencies. The tuning condensers are ganged in pairs, and the two drum dials are mounted side by side in an escutcheon plate on the front of the cabinet. The left-hand drum controls the aerial and first H.F. circuit, which is comparatively flatly tuned. The remaining H.F. circuits are more selective, and are controlled by the right-hand drum. A

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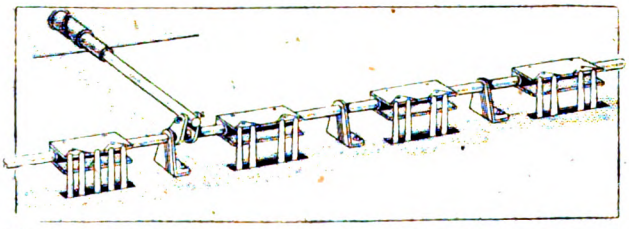
Broadcast Receivers—Columbia All Electric Model 304.— friction device couples the two drums, which, once set, can be moved together over the whole of both long- and short-wave ranges. All the contacts for wave-range switching are assembled on a horizontal shaft running underneath the chassis. A rocking motion is imparted to this shaft by the "Selector" knob on the front panel, which actuates a spiral-slotted sleeve.

Mullard P.M.12 screen-grid valves are used for all three H.F. stages, and some idea of the overall amplification obtained can be gathered from the fact that the anode bend detector, an Osram L.210, is biased to 16 volts negative. The H.F. amplification is sufficient to feed a considerable voltage to the detector even from distant stations, and it is found that resistance coupling between the detector and a P.625 output valve gives all the low-frequency amplification necessary to supply a moving-coil loud speaker. Stray H.F. currents are kept from the grid of the power valve by a series resistance of the Loewe vacuum type. A five-pin valve holder is now fitted for the output stage, and the centre socket is supplied with the necessary positive potential so that a pentode may be used if desired. In the D.C. mains model the loud speaker terminals are supplied through a transformer in accordance with I.E.E. regulations. In all other cases the loud speaker is connected directly in the anode circuit of the last valve.

Volume Control.

The volume control takes the form of a resistance regulating the filament current of the first H.F. valve. The regulating resistance is in the form of a potentiometer in order to keep the load on the filament circuit constant. By confining the volume control to the first H.F. valve and keeping the second and third valve filaments at normal temperature, distortion due to progressive rectification is avoided.

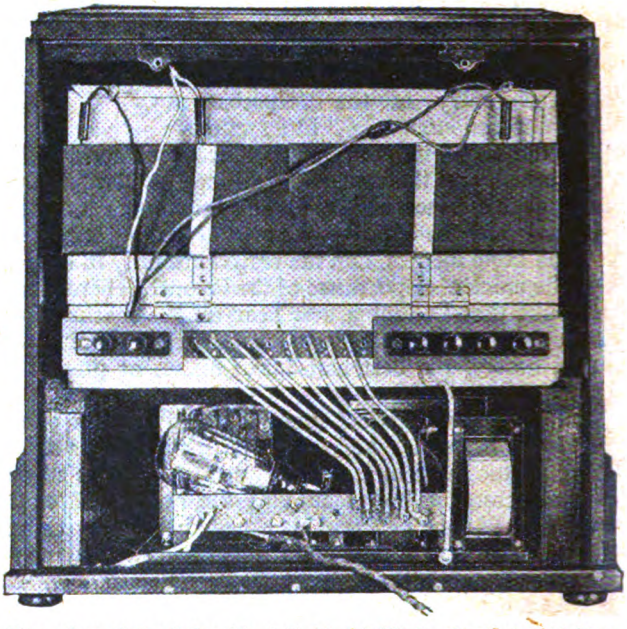
The particular model tested was equipped for A.C. mains, and is especially interesting on account of the arrangements for heating the valve filaments. The 2-volt filaments of the three H.F. valves and the detector are supplied with direct current through a Westinghouse



Wave-range switch mechanism. The contact blades protrude through slots in the aluminium screen and are short-circuited by contacts mounted on paxolin insulating strips.

metal rectifier, a smoothing choke, and electrolytic condenser, while the P.625 is heated with raw A.C. from a separate winding on the mains transformer. High-tension current is derived through a U.5 full-wave rectifier, and the usual smoothing chokes and condensers.

The receiver was tested within sight of the Brookmans Park aerials (5¾ miles, to be exact), using an outdoor aerial 75ft. in length. With the aerial connected to terminal A_1 (the smallest series condenser) the tuning drums were first adjusted in step, when it was found that the wavelength figures on each dial exactly coincided on both wave ranges. This setting was maintained over the whole of both ranges, and although a slight improvement seemed to result from readjusting the relative setting at the top of each range, the difference was not sufficient to justify frequent alterations. With the dials properly adjusted, at least 30 stations were received on the short waves at good loud speaker strength and without mutual



Rear view of the Columbia A.C. Model 304 G, showing grid bias battery mounting and leads between receiver unit and eliminator.

interference. One can state without exaggeration that it is difficult to find any space on the dial unoccupied by some British or Continental transmission. Yet the selectivity is distinctly above the average. Bearing in mind the size of the aerial and the distance from Brookmans Park, the selectivity may be judged from the following facts: The London transmission was inaudible outside the band 275-390 metres, and 5GB occupied only 10 metres on either side of its normal wavelength. Using a shorter aerial, the width of these interference bands could be considerably reduced without appreciably restricting range.

The first impression on switching over to long waves was the entire absence of mush and background noise usually experienced on this wave band. All the high-powered stations came in with remarkable volume and clarity. The selectivity, however, was not of such a high order as on the short wave range. No difficulty was experienced in receiving Radio-Paris clear of 5XX, but Königswusterhausen, between these two stations, could only be heard during intervals in the 5XX programme. It was noticed, also, that Brookmans Park was forcing itself through in the lower part of the dial up to about 1,000 metres. Here, again, a shorter aerial would undoubtedly effect a cure.

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Broadcast Receivers—Columbia All Electric Model 304.—

The smoothing arrangements in the A.C. eliminator do their work well, and there is no trace of 50-cycle hum or any other extraneous noise.

The volume control is smooth and noiseless in operation, but in the receiver tested its action was restricted for most stations to approximately one-third of the total movement. With Brookmans Park accurately in tune, however, the remaining two-thirds could be usefully employed. A rearrangement of the resistances in the potentiometer scheme, so as to distribute the control more evenly over the range of movement available, would be a welcome detail improvement.

As is only to be expected, in an instrument emanating from a firm of long standing in the art of acoustic reproduction, the quality of reception is beyond reproach.

The price of the battery model is £27. The A.C. and D.C. mains models are both priced at £33.

"WORLD BROADCASTING" FROM GERMANY.

GERMANY'S short-wave "world" broadcasting station at Königswusterhausen (Zeesen) has now begun testing. In external design the short-wave plant strongly resembles the Telefunken Company's standard long-wave transmitters for wireless telegraphy, while in technical construction it is similar to that of the two high-power short-wave transmitters used on the Nauen-Buenos Aires service.

The new transmitter has a single wire aerial about 180ft. long, which is suspended from one of the masts of the long-wave plant. The mean aerial energy, i.e., carrier wave without modulation, is 8 kW., and the wavelength is 31.38 metres.

The transmitter consists of seven units, with crystal modulation on the first. The short-wave is obtained by making use of the harmonics of a comparatively low frequency in the crystal-controlled oscillator. Suitable filters and amplifiers in the ensuing stages produce the desired reduction of wavelength and power when the final stage is reached.

The valves in the individual stages are accordingly arranged to give a successive increase in power. The first stage functions with one valve of the power-amplification type, while the second stage embodies a small transmitting valve of the 0.75 watt class. Two similar valves in parallel make up the third stage, and three in parallel comprise the fourth stage. The fifth stage contains a single transmitting valve of average power (about 1,500 watts), and the succeeding stage contains two valves of the same type in parallel. The seventh and final functions with two 20 kW. water-cooled valves in push pull. Modulation on the well-known grid principle takes place in the sixth stage with the aid of three modulating valves connected in parallel.

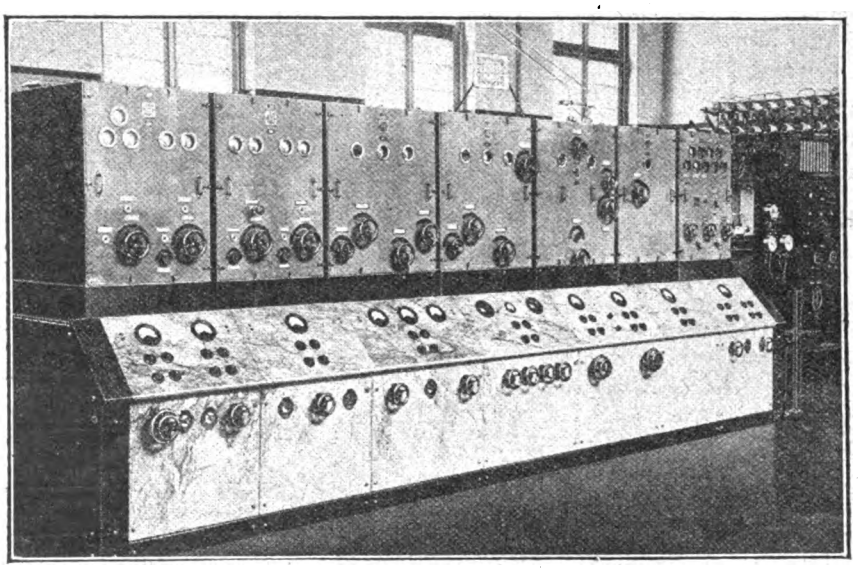
This arrangement of valves, of course, necessitates separate supplies of power. A high-tension D.C. dynamo of 50 kW. 10,000 volts is used for feeding the anodes in the last stage; the valves in the fifth and sixth stages are fed by means of a 4,000-volt D.C. machine of 5 kW. In the second, third and fourth stages the anode current is supplied from a common source, viz., a 2,000-volt D.C. dynamo of 2 kW., whilst the crystal stage is fed by a 220-volt machine. For filament heating in all except the last stage a 20 v. 2 kW. D.C. generator is used. A 40 v. 5 kW. generator heats the water-cooled valves in the final stage.

The filaments of the modulating valves are heated by an alternator of high periodicity. Grid bias for the water-cooled valves in the last stage needs to be of a high value, taking into consideration the size of the valves and the high anode current, and is supplied by a special converter of 750 v. 2 kW.

All machines are started by means of push-buttons on the switchboard, which is built into the lower portions of the transmitting panels. The supply current for the converter is derived from the transformer already in use at the station connected with an overhead electrical distribution system.

Besides the actual transmitter there is also a low-frequency amplifier dealing with the speech currents arriving from the land line, and the anode circuit of this amplifier is fed by an additional small converter.

The entire installation is equipped with measuring apparatus enabling the performance of every portion of the transmitter to be checked.



ZEESEN'S NEW SHORT-WAVE TRANSMITTER. Working on a wavelength of 31.38 metres and a power of 8 kW, this crystal-controlled station represents Germany's latest contribution to world broadcasting.

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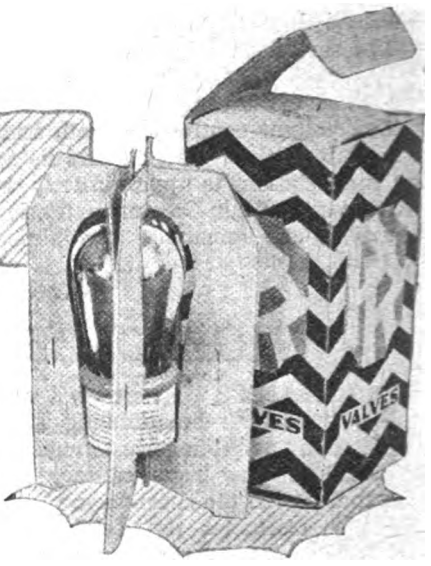
VALVES TESTED

The 1929 P.R. Series.



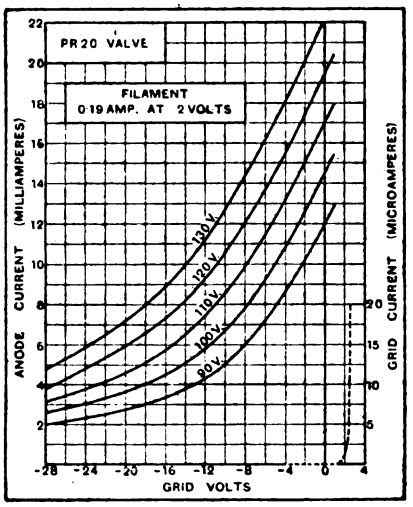
THESE valves are made by Messrs. Peter Russell, 14, Newgate Street, London, E.C.4, and are supplied with 2-, 4- and 6-volt filaments. Each class consists of four distinct types, viz., H.F. and Det., R.C., L.F. and power. The prices of these valves are very reasonable, being somewhat lower than usual. The H.F., R.C. and L.F. types are priced at 3s. 6d., and the power valves at 6s. 6d. each. Super-power valves are made in the 2- and 4-volt ranges only; they are offered at 10s. 6d. each.

The Two-volt Range.

The valves in this range are numbered P.R.2, 3, 4 and 20. The P.R.2 is an H.F. and Detector valve, the P.R.3 an L.F. amplifier, the P.R.4 a high-impedance valve for R.C. coupling arrangements or anode-bend rectification, and the P.R.20 a power output valve. A sample of each of these valves was tested and the characteristics measured. These results are tabulated below, the makers' figures being given also, as a basis for comparison.

With one exception, the measured values agree sensibly with the makers' rating. The sample P.R.4 tested would appear to be a faulty specimen.

A full set of curves was taken of the P.R.20, the power valve of this series, and from these some useful information can be gleaned.



Average values under normal working conditions: A.C. resistance, 4,600 ohms; amplification factor, 3.1, and mutual conductance, 0.67 mA/volt.

Under working conditions, with 120 volts on the anode and −10.5 volts grid bias, the average A.C. resistance was found to be 4,600 ohms, the amplification factor 3.1, and the mutual conductance 0.67 mA. per volt. Grid current did not start until the grid was given a positive bias of 1.5 volts. The characteristics, particularly with low anode voltages, show a pronounced curvature, so that in the interests of quality of reproduction it would be advisable to apply slightly less negative bias than a casual examination of the curves would lead one to believe is the optimum value. The following values are suggested:—

P.R. 20.

H.T.	Grid bias.	Anode current.
100	− 7.5 volts	8.2
110	− 9 ,,	9.2
120	− 10.5 ,,	10.2
130	− 12 ,,	11.2

When this valve is used in the output stage of the set the loud-speaker could be connected direct in the anode circuit. Dry-cell H.T. batteries may be used economically, since the anode current is well within the capacity of the larger sizes to supply.

There is a super-power valve in this series, namely, the P.R.120. A sample was not available for test, but the makers give its characteristics as: A.C. resistance, 3,800 ohms; amplification factor, 4; and mutual conductance 1.05 mA. per volt. The price of this valve is 10s. 6d.

The Four-volt Range.

This class contains a similar number of valves as in the 2-volt

P.R. 2-VOLT VALVES.

	Makers' Rating.			Characteristics measured at H.T. = 100 v. G.B. = 0.		
Type.	A.C. Resistance (Ohms).	Amplification Factor.	Mutual Conductance.	A.C. Resistance (Ohms).	Amplification Factor.	Mutual Conductance.
P.R. 2	28,000	13	0.46 mA/v.	33,300	20	0.6 mA/v.
P.R. 3	15,000	8	0.53 ,,	10,000	9	0.9 ,,
P.R. 4	60,000	32	0.53 ,,	33,400	11.8	0.35 ,,
P.R.20	7,000	6	0.86 ,,	4,700	3.8	0.8 ,,

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Valves Tested.—

series. They are numbered P.R.9 (H.F. and Det.), P.R.10 (L.F.), P.R.11 (R.C.), and P.R.40, the power valve. In addition, a super-power type is available, the P.R.140. One sample each of the first four mentioned was submitted for test, the measured characteristics being tabulated below:—

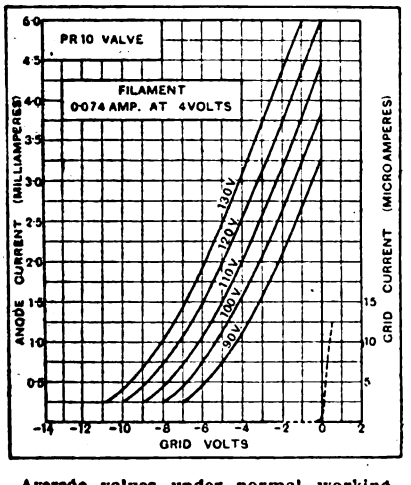
P.R. 4-VOLT VALVES.

Type.	Makers' Rating. A.C. Resistance (Ohms).	Amplification Factor.	Mutual Conductance.	Characteristics measured. at H.T. = 100 v. G.B. = 0. A.C. Resistance (Ohms).	Amplification Factor.	Mutual Conductance.
P.R. 9	24,000	14	0.58 mA/v.	77,000	20	0.26 mA/v.
P.R.10	15,000	8.7	0.58 ,,	18,000	11	0.6 ,,
P.R.11	65,000	40	0.62 ,,	71,000	25.6	0.36 ,,
P.R.40	8,000	6	0.75 ,,	3,570	4	1.1 ,,

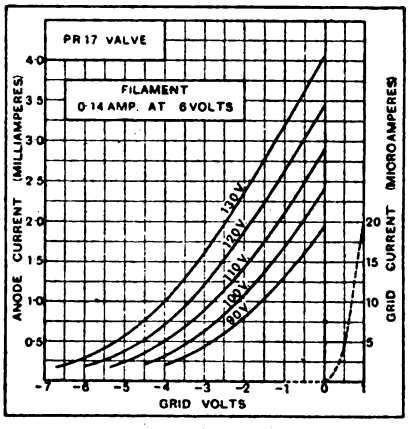
A full set of curves was taken of the P.R.10, the L.F. valve, as it is a representative specimen and showed a mutual conductance very close to that of the makers' rating. This will make a good first stage L.F. amplifier, and can be followed by a transformer, as the anode current is relatively low. Under normal working conditions, with 120 volts H.T. and $-4\frac{1}{2}$ volts grid bias, the anode current will be of the order of 2.3 mA. only. The A.C. resistance remains unchanged as compared with that at 100 volts H.T., but the amplification drops to 9.5. The result is a slight lowering of the conductance, from 0.61 to 0.52 mA. per volt.

The P.R.9, which is the H.F. valve, could be used in a neutralised high-frequency stage, or as a leaky grid detector. As a grid detector, with the grid leak returned to a point of positive potential, an anode voltage of about 60 to 80 volts would be about correct. The anode current will be relatively low, less than 2 mA. probably, so that it could be followed by transformer-coupling. The specimen tested was not a good sample, so that precise figures cannot be given.

The P.R.40 power valve takes about the same anode current as its 2-volt counterpart, and dry-cell H.T. batteries will prove economical in this case also.



Average values under normal working conditions: A.C. resistance, 18,200 ohms; amplification factor, 9.5, and mutual conductance, 0.52 mA/volt.

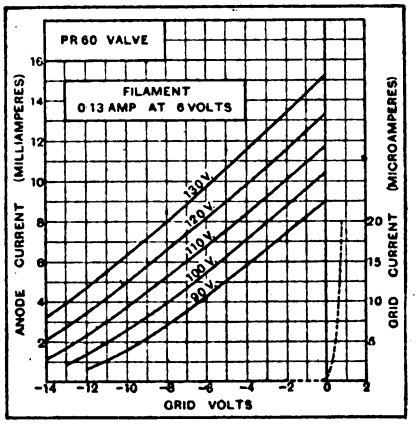


Average values under normal working conditions: A.C. resistance, 25,000 ohms; amplification factor, 16.6, and mutual conductance, 0.68 mA/volt.

The Six-volt Range.

These valves are numbered P.R.17, 18, 19 and 60, and comprise H.F. and Det., L.F., R.C. and power. A super-power type is not listed.

The P.R.17 is an optional H.F. or detector valve, and could be used in a neutralised H.F. stage. In this case the best operating conditions would be 120 volts H.T. and $-1\frac{1}{2}$ volts grid bias. As a leaky grid detector about 60 to 80 volts H.T. would be required, and the grid given a small positive potential. It is suggested that a potentiometer is used, as the positive potential obtained by returning the grid leak to the positive L.T. would be somewhat excessive. The anode current can then be kept below 2 mA., and transformer-coupling could be used between the detector and the following valve.



Average values under normal working conditions: A.C. resistance, 8,000 ohms; amplification factor, 6, and mutual conductance, 0.75 mA/volt.

The P.R.60 is a power valve suitable for use in the last stage where moderate volume is required from the loud speaker. This may be connected direct in the anode circuit of the valve, since the H.T. current is not on the high side. Under normal working conditions this will be about 6 mA.—that is, assuming 120 volts H.T. and grid bias of -9 volts. The valve falls within the ordinary power category, and costs 6s. 6d.

P.R. 6-VOLT VALVES.

Type.	Makers' Rating. A.C. Resistance (Ohms).	Amplification Factor.	Mutual Conductance.	Characteristics measured at H.T. = 100 v. G.B. = 0. A.C. Resistance (Ohms).	Amplification Factor.	Mutual Conductance.
P.R.17	24,000	17	0.7 m/Av.	20,500	16	0.78 mA/v.
P.R.18	15,000	9	0.6 ,,	27,000	8	0.31 ,,
P.R.19	80,000	40	0.5 ,,	40,000	21	0.51 ,,
P.R.60	8,000	6	0.75 ,,	7,150	6.15	0.86 ,,

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CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

TELEVISION.

Sir,—In reading Mr. Bradford's letter in your issue of August 28th on Mr. Samuel Izenstark's prophecy of television sets being installed in 14 million homes in America *by now*, the exact position can be deducted from an extract of Dr. Lee De Forest's article, "The Reminiscences of a Radio Pioneer," from September's issue of the American wireless magazine, *Radio News*:—

"To my mind, we are entering a new era in radio—television. In time sight will come to join hearing in the complete home entertainment *via* the air. There are many problems in television. Our present efforts are not to be compared with the perfection of present broadcasting, but rather with my own crude attempts at broadcasting back in the days of acousticon microphones, carbon arcs and the phone receiver and microphone method of coupling. C. Francis Jenkins, pioneer in the field of television, has already made notable progress. . . .

"The vacuum tube (valve) is going to play an important role in television. Indeed, but for the audion, television would be quite impossible; for let us not forget that the principles of present-day television date back several decades, but the fine means of applying those principles have been missing. We had the theory but not the practice until now. I look forward to remarkable audion developments, with tubes of tremendous amplification factors so as to handle the delicate television impulses without distortion. The problem of distortion must always be a far more serious one in reproducing the television image than in reproducing the tone picture, for the eye is far more critical than the ear. Therefore, I envisage audions of enormous amplification possibilities, used sparingly—not many stages of amplification—so as to reduce distortion to a minimum. I look forward to more powerful light sources than the present neon lamps. I expect intricate methods of dividing the television image into a large number of sections for simultaneous transmission and assembly, for greater detail. All these things are quite possible and probable, but it takes time, effort, and much money."

I trust this will interest everyone whose thoughts are turning to the prospects of television in the near future.

Croydon. H. GRAHAM MALLETT.

THE B.B.C.

Sir,—In view of the inauguration of the Regional Scheme and the absence of any appreciable criticism of the recent activities of the B.B.C., presumably due to the triumph of hope over experience, I should like, as a not very satisfied listener, to make the following suggestions in the hope that they may be of interest not only to other listeners but also to the B.B.C. itself.

First, with regard to programmes, these may presumably be considered as fairly satisfactory as a whole, but the following alterations would be definitely advantageous, at least to provincial listeners, for, after all, everyone does not live in London. Occasionally some programme worth listening to might be put on from, say, about 6.30 until 9, and the conglomeration of talks relegated to later in the evening. It should be observed that people in the North of England usually rise and go to bed at least an hour earlier than is common in London, and consequently the general tendency for the parts of the programme that are thoroughly worth listening to to be put on very late is troublesome to anyone living in the provinces.

This state of affairs may possibly be remedied when the Regional Scheme is fully in operation.

The next point about programmes is that it is devoutly to be hoped that all the regional stations will not broadcast the London programme. I know that this is not supposed to be the intention, but I am merely going by my experience up to the present, which shows, for example, that Manchester and nearly all the northern stations regularly broadcast little else but London programmes after 9 o'clock almost every evening, with the result that with the average set only the London programme can be received, as 5XX always broadcasts the London programme, and 5GB is not as a rule easily receivable. With a reasonably good set, of course, one can tune in the Continent and not be dependent on the B.B.C., but this is not a satisfactory state of affairs, particularly bearing in mind that one has to pay one's licence whether listening to the B.B.C. or otherwise.

On the technical side of broadcasting there seems to be room for some improvement in the following direction: it seems that it would be much better if the degree of modulation used by all stations could be the same, or at least could be the same for broadcasts of a similar general character, and, although there may be some very serious technical obstacles in the way of doing this, I should like to be informed as to what they are, as most people know the perfect detector has not yet arrived and each kind of detector functions most efficiently with a certain definite amount of modulation.

This difference in modulation makes it very difficult to make accurate comparisons of the quality of the broadcast from different stations, and, of course, this may be the intention.

Referring to the broadcasts of gramophone records, it is to be hoped that the B.B.C. can afford to put aside an amount equivalent to that provided by comparatively few licences, to enable them to install electrically operated turntables and good pick-up devices, so as to avoid the amount of scratch that is put over, but most especially so that the turntable motors do not run down in the middle of records, as has frequently happened in the past.

A further matter that might be considered in connection with the broadcast of gramophone records is that it should not be necessary for distressing overloading at the transmitting end to occur with any particular record before adjustments are made at the transmitting end so that the broadcast is in order, but apparently in this particular direction the B.B.C. facilities are no better than those of the ordinary experimenter. Of course, it may be that gramophone records are considered to be beneath the dignity of proper attention when they are broadcast, but owing to the facility whereby records can be used to provide a really attractive programme, this surely should not be the case.

Manchester. J. BAGGS.

Sir,—I have been an enthusiastic wireless "fan" since the year "dot," and am, of course, much interested in your editorials and the correspondence about the regional scheme. I think your opposition to Brookmans Park is badly founded, inasmuch as your main argument appears to be that it interferes with those who wish "to receive transmissions from abroad which they have hitherto enjoyed. Are you suggesting then, that the B.B.C.'s first consideration should be to facilitate foreign transmissions being received in this country? I should have thought that the correct policy is to give as good a service as possible, in this country, of British broadcasting. If the main consideration is to be whether or not the "reacher out" is to be inconvenienced, then surely the B.B.C. ought to close down altogether!

Then, again, I disagree with you about the "enjoyment" of foreign programmes. My own set is reasonably up-to-date—it is one of your own excellent designs—and I can get, practically any night now, from 10 to 15 foreign stations at reasonable strength on the loud speaker. My experience of "foreign listening" compels me in honesty to say that the "enjoyment" of foreign transmissions is an absolute myth, and I feel almost sure that there is not 1 per cent. of your readers who can honestly put their hands on their hearts and say that they really and truly "enjoy" these awful noises—transmission *plus* mush *plus* atmospherics *plus* heterodynes *plus* fading *plus* morse. I grant the "fascination" of reaching out, but utterly deny the "enjoyment" of the results.

No Sir! The "fascination" of reaching out is the *last* thing the B.B.C. should take into consideration.

Chipstead, Surrey. A. W. SCOTT.

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READERS' PROBLEMS

THE WIRELESS WORLD SUPPLIES A FREE SERVICE OF TECHNICAL INFORMATION

The Service is subject to the rules of the Department, which are printed below: these must be strictly enforced in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Wasted Energy.

I have a 50-volt house-lighting plant, with a battery of accumulators. Would it be practicable and economical to charge my 6-volt L.T. battery from this source? V. W. P.

It would be practicable, but not economical. This is because more than four-fifths of the energy consumed from your battery would be wasted in heating the necessary voltage-dropping resistance.

o o o o

An Old Friend.

Have you ever published any constructional details of the band-pass filter arrangement shown in Fig. 1 (a) of the article entitled "Selectivity and Quality," which appeared in your issue of October 30th? If you have not, I should particularly welcome a word of advice as to the number of turns suitable for the inductance L_1, which, I assume, acts as a coupling between the two separate tuned circuits. E. B. C.

If you consider carefully the circuit diagram of several recent *Wireless World* receivers, such as the S.G. Regional set and the 1930 Everyman Four, you will see that the filter arrangement to which you refer is similar in essentials to the aerial-grid circuits of these sets. We have redrawn this conventional filter circuit, showing it in comparison with the aerial input arrangement of the sets mentioned in Fig. 1 (a) and (b) respectively.

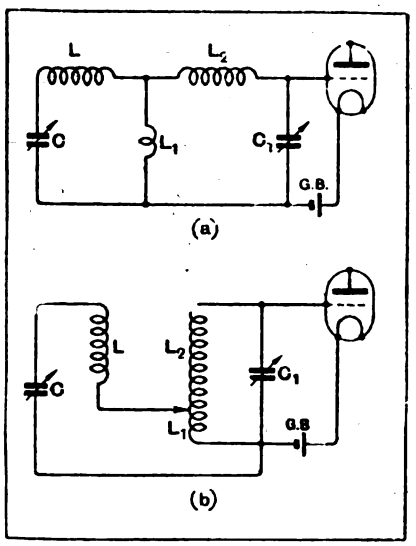

Fig. 1—Conventional inductance-coupled filter (a) compared with a popular aerial circuit arrangement (b).

It should be realised that the coupling inductance L_1 is common to both circuits, and, instead of using a separate winding for the purpose of coupling, one can make a tapping on to either of the tuning coils; this latter arrangement is that adopted in *The Wireless World* sets.

It should be pointed out that in the arrangement shown in Fig. 1 (b), inter-circuit coupling is not purely inductive, as there is also a mutual inductance effect, and it is only in this respect that there is difference between the arrangements.

Full details of the windings are given in the articles in which the receivers are described.

o o o o

0.0003 or 0.0005.

I notice that in the many two-circuit aerial tuners described in "The Wireless World" of late, a 0.0005 mfd. condenser is invariably used for aerial tuning. Is this absolutely necessary? I have several spare 0.0003 mfd. condensers, and should like to use one of them, if possible, in altering my present receiver. L. C. G.

Unless a fairly large condenser is used for aerial tuning, it will be found that it is impossible to cover the entire broadcast band without a change of aerial coil, this in spite of the fact that the disturbing effect of aerial capacity is to a certain extent removed by the usual practice of fitting a fixed condenser of 0.0002 mfd. in series with the aerial.

If you wish to use one of your present variable condensers for the aerial circuit, it will be found necessary to make provision for changing coils, or, alternatively, to use so small a series condenser in the aerial circuit that signal strength will almost certainly be considerably less than it need be.

o o o o

A Source of Electrical Interference.

I am puzzled as to the reason why I should be troubled by interference from my domestic electric light wiring, while my next-door neighbour, whose supply is from the same source, is quite free from this interference. Our houses are almost identical, the wiring systems are similar, and neither of us uses any electrical machinery or appliances other than lamps. Can you explain? F. D. R.

Very possibly there is an intermittent disconnection in your wiring, and we advise you to examine all switches, fuse boxes, junctions, etc. If these are in order, it is probable that your trouble is due to a failure of the earthing system, and you should make sure that the sheathing of the wires (or the metal conduit, if used) is properly "bonded" together and connected to earth.

o o o o

Why a Bigger Condenser is Necessary.

After handling a friend's receiver fitted with differential reaction, I decided to instal one of the new three-element condensers in my own receiver, and chose a capacity of 0.0001 mfd., which is the same as that originally used. The condenser is connected in the manner shown in your journal some time ago; but, much to my surprise, reaction control is not so good as it was before making the alteration; in fact, it is impossible to obtain oscillation except when the moving vanes are fully in mesh with the set of fixed plates which are in connection with the reaction coil. Do you think that the reaction windings of my coils are unsuitably proportioned for this method of control? J. W.

It must not be taken that the feed-back through a differential reaction condenser of 0.0001 mfd. is equal to that of a normal condenser. This is due to the fact that there is a by-pass effect, as the second stator is connected to earth; in consequence, there is less energy passed back through the reaction coil, except when the rotor is at the "full-on" setting.

We expect your trouble will disappear if you fit a condenser with a capacity of, say, 0.0002 mfd. between the rotor and each stator. We recommend this course because the larger capacity will probably improve detection efficiency, but, if you prefer it, matters could be improved by adding turns to the reaction coil.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Job's Comfort.

Signals from the new 2LO spread over a fairly wide section of my tuning dials, and I have come to the conclusion that, unless I make a radical improvement to my receiver, the opening of the alternative programme station will entirely prevent reception on the lower part of the tuning scale, even if there is no mutual interference between the two transmitters. Before starting reconstruction of my set, I should like to ask you if it is logical to assume that interference from the new station will spread over a band of wavelengths of the same width as that occupied by the present transmission. R. T. S.

We fear that you are over-optimistic in making this assumption. It is proposed that the alternative-programme station shall work on a lower wavelength than that of the present 2LO, and, as the circuits used in ordinary receivers tend to become less selective at the lower end of the tuning scale, it will be found that the band of frequencies over which interference is present will be wider.

should be any serious loss. Matters are so arranged in the design that there is a certain amount of "pulling" between aerial and secondary circuits, without the need for observing any special precautions in operation. This tends to correct any high-note loss in the tuned intervalve circuit, and the overall result is that the set gives "bright" reproduction.

oooo

Using the High-power Pentode.

I am thinking of making the Foreign Listeners' Four, as described in "The Wireless World" for July 31st and August 7th, and should like to know if it would be possible to use a P.M. 24A. pentode valve in the L.F. position. If so, will you give me some idea as to the alterations that will be necessary? I can get a power transformer delivering 310 volts across each half of the high-tension secondary, and with suitable low-tension outputs. L. P. A.

There is no reason why the new high-voltage pentode valve should not be used in this receiver, and we give in Fig. 2 a

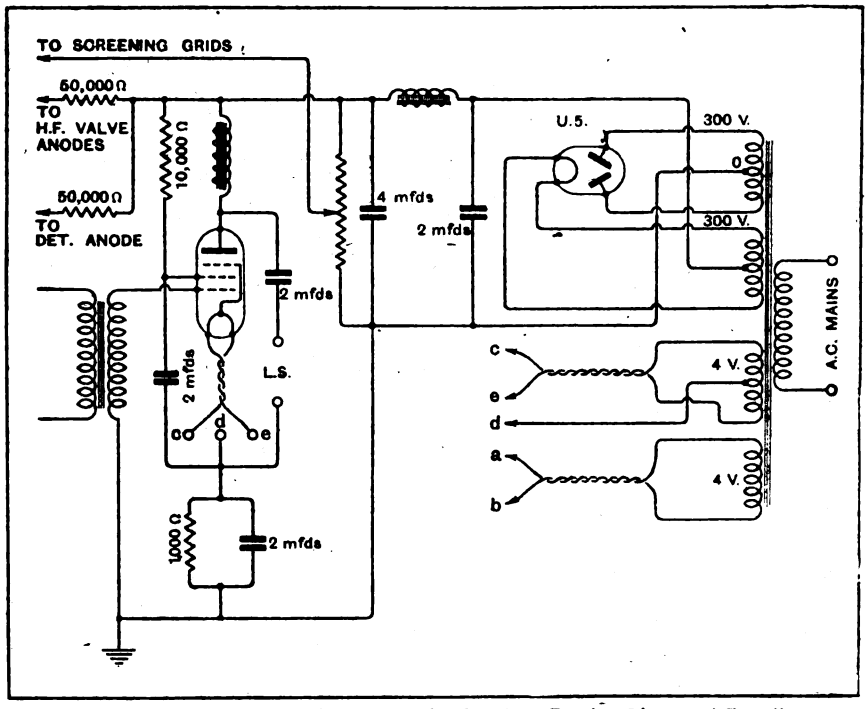

Fig. 2.—Super-power pentode output valve for the "Foreign Listeners' Four": diagram showing circuit modifications.

Side-band Loss.

Will you give me an idea as to the probable loss of side-bands in the "1930 Everyman Four" receiver? E. F. E.

It is not possible to give a definite answer to this question, as a good deal depends on the way in which the set is operated. As you will know, a coupled tuned aerial circuit is provided, and if the receiver is operated in such a way that there is a tendency towards double-humped tuning—but there should not be more than a mere tendency towards this effect—there is no reason why there

circuit diagram showing the necessary modifications.

You will see from the diagram that the potentiometer controlling the screening grid voltage is retained; there would be no harm in increasing its value slightly in order to counteract the increase in current through it, which is due to the higher voltage delivered by the rectifier. It will be necessary to insert a voltage-dropping resistance in series with the feed lead for the H.F. valve anodes, and also to increase the value of the resistance provided in the original design for the detector anode circuit. It is advisable to decouple the screen circuit of the pentode in the manner shown, and, as you will doubtless realise, care must be taken to see that the low-tension windings of the power transformer which feeds the output valve filament is redesigned, in order that it may deliver a lower voltage suitable for the pentode filament.

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Two Sets Compared.

Will you please give me an idea as to the relative selectivity of the "1930 Everyman Four" and the "Wireless World Kit Set"? Up to and including the H.F. stage, both receivers have many obvious points of similarity, and I am undecided as to which to choose. T. F. C.

Both these receivers are well above the average in the matter of selectivity, but there can be no doubt that the "1930 Everyman Four" is the better of the two in this respect. Not only does it include a more selective form of aerial coupling, but all the circuits in it are of lower H.F. resistance, and—as important as anything else—it makes use of anode bend detection, which always tends to prevent the spreading of unwanted signals, provided their strength is reduced by detuning to a value considerably less than that of the signals which it is desired to hear.

FOREIGN BROADCAST GUIDE.

KOENIGSWUSTERHAUSEN

(Zeesen) (Germany).

Geographical position: 52° 17′ N. 13° 37′ E.
Approximate air line from London: 588 miles.
Wavelength: 1,635 m. Frequency: 183.5 kc. Power: 30 kW.
Time: Central European (one hour in advance of G.M.T.).

Relays Berlin (Witzleben) and other German stations, but gives an alternative main evening programme; works throughout the day from 5.55 a.m. G.M.T. with talks, etc., including the following principal standard daily transmissions, G.M.T.:—

5.55 a.m. weather; 6 a.m. physical exercises from Berlin; 11 or 11.30 a.m. gramophone records; 1.30 p.m. children's hour; 7 or 7.30 p.m. main evening concert.

A male announcer. Call: *Achtung! Achtung! Hier Koenigswusterhausen und der Deutscher weltrundfunksender auf welle ein und dreissig komma acht und dreissig.* (This is Koenigswusterhausen and the German world transmitter on 31.38 m.).

When relaying Berlin, this station, as well as Magdeburg and Stettin, are included in the call.

Interval signal: Metronome. 120 beats per minute.

Closes down with the German National Anthem, played to the melody of the Old Austrian Hymn (Haydn).

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.

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(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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VALVE DATA SUPPLEMENT.

WITH this issue we publish as a separate sheet a Valve Data Supplement, giving technical and other information regarding representative radio receiving valves on the British market.

Readers will find that the information published is very much more complete than anything which has hitherto been attempted, as, for instance, the inclusion of a column giving the A.C. power output in milliwatts of some eighty-five different valves. This information has not been available previously and should prove of very great value to those concerned with the design of receivers. The inter-electrode capacities of most of the screen grid valves are given and the maximum attainable stage gain of these valves, calculated on the basis of the inter-electrode capacity.

The inclusion in this issue of an article having special bearing on the Valve Data Supplement provides, it is believed, all the assistance necessary to readers who wish to make the best use of the information which the supplement contains.

VALVE SUPPLIES.

MANY readers have written to us stating that they have found it impossible to obtain certain valves of the new Mazda series, such as have been incorporated in the designs of recent *Wireless World* receivers, through the usual trade channels.

On enquiry from the manufacturers, we learn that the demand for these valves has been so great that it is impossible at present to issue adequate supplies to retailers, although we understand that the position is rapidly improving.

As a temporary measure, however, until production is able to cope with the demand, the manufacturers have kindly undertaken, at our request, to supply valves if readers of *The Wireless World* write direct to them at the Edison Swan Electric Co., Ltd., Service and Installation Department, 1A, Newman Street, Oxford Street, W.1, ordering the valves they require and stating for what *Wireless World* receiver they are to be used. It is essential that applicants should give the name and address of their local radio dealer. Valves will be despatched to readers by post, c.o.d., the charge being the usual retail selling price of the valves, plus cost of postage. Prompt application should be made for the valves by readers who wish to avail themselves of this opportunity, as this special arrangement can only be regarded as a temporary measure.

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THE HAGUE CONFERENCE.

AN interesting report has recently been received of a statement made by the Chairman of the U.S. Delegation to the recent Radio Conference at the Hague on his return to Washington.

The statement would lead one to suppose that the American delegates had things very much their own way at the Conference. In his report the Chairman says: "The proposals and studies prepared in Washington last summer and sent out by the U.S. to all nations were taken as the basis of discussion at the Hague, and in almost every case were adopted, not always with our original wording, but with our original intent." The Chairman is also reported to have stated, "I think, perhaps, the splendid technical contribution made by the U.S. Delegation at the Hague in 1929 will enable the next meeting at Copenhagen, in 1931, to dodge the troublesome 'English' questions by authorising the use of the 'American' language instead of 'English.'"

It would appear that the U.S. attaches more importance than other countries to the question of obtaining a dominating position in International radio discussions.

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MEASURING THE INTERELECTRODE CAPACITY OF SCREEN-GRID VALVES

Details of the Apparatus Used.

By T. H. KINMAN

(Of the British Thomson-Houston Company's Engineering Laboratory at Rugby).

THE importance of reducing the interelectrode capacity between the anode and control grid in screen-grid valves in order to obtain a degree of stable amplification at high frequencies is well known and has been the subject of recent discussion.[1]

A method of measuring this capacity was described by A. W. Hull and N. H. Williams in 1926,[2] and more recently another method has been described by N. R. Bligh, B.Sc.[3] The method described in this article is based on the substitution method, outlined by Hull and Williams, in that the valve capacity is determined by observing the capacity change required in a standard condenser connected in parallel with the valve capacity when coupled between an R.F. source and amplifier to obtain the same amplifier output reading when the valve capacity is removed. The bare theoretical circuit

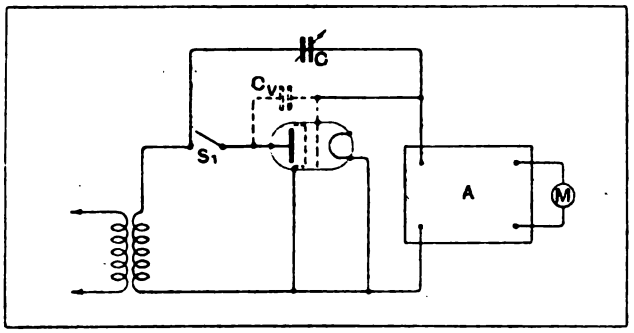

Fig 1.—Schematic diagram of apparatus used for the measurement of valve interelectrode capacities.

arrangement is shown in Fig. 1, in which the R.F. source is coupled to a screened amplifier A through the valve capacity C_v and standard variable condenser C. A meter M indicates the degree of coupling between the R.F. source and amplifier caused by the coupling capacities $C_v + C$.

The meter reading is noted when both C_v and C are in circuit. When S_1 is open C_v is removed from circuit and C is then increased until the original meter reading is obtained. The *change* in capacity to produce this effect is equal to the coupling capacity of the valve and can be determined from the known physical constants of the condenser C which will be described later.

[1] See *Experimental Wireless*, June, 1929, page 293; also *The Wireless World*, July 24th, 1929, page 68.
[2] *Physical Review*, Vol. 27, April, 1926.
[3] *Experimental Wireless*, June, 1929, page 299.

The three interelectrode capacities present in a screen-grid valve are represented in Fig. 2 by C_{as}, C_{gs}, and C_v respectively, the value of C_v, which is desired, being but a small fraction of C_{as} or C_{gs}.

In testing this circuit it was found that the results obtained were not consistent with the above simple theory, the cause being traced to the shunting effect of the anode-to-screen capacity of the valve under test. The effect of this capacity when switched in or out of circuit is to react upon the R.F. source and alter the impressed voltage or frequency or both, so vitiating the readings. This effect was small with the early types of valves such as the Hull, or where the capacity C_v is relatively large, but with valves of the AC/S type, the anode-screen capacity is relatively larger and the coupling capacity C_v very small, therefore the effect of the former capacity must be taken into account.

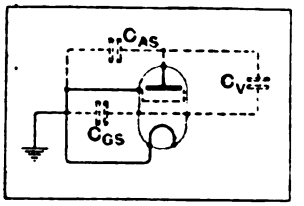

Fig. 2.—Equivalent circuit showing the three interelectrode capacities present in a screened valve.

This difficulty was overcome by using a small variable condenser C_1, as shown in Fig. 3, to replace the valve capacity C_{as} when the switch S_1 was operated, C_1 being adjusted to balance exactly the effect of C_{as} on the input voltage. In order to adjust C_1, however, it was necessary to remove the coupling through the valve to the amplifier when the switch S_1 connects the valve in circuit, otherwise the effect of the capacity coupling through C_v would be included in the balancing adjust-

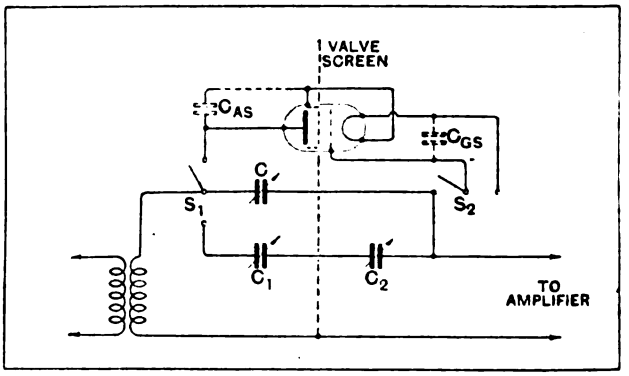

Fig. 3.—The circuit arrangement which was designed to overcome the shunting effect of the anode-to-screen capacity of the screened valve.

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Measuring the Interelectrode Capacity of Screen-grid Valves.—

ment. The coupling capacity C_v was, therefore, removed by means of switch S_2, which disconnected the control grid from circuit, a small condenser C_2 being provided to compensate for the removal of the valve capacity C_{gs}, which is normally in shunt with the input circuit of the amplifier. C_2 can, however, be dispensed with, but a compensating adjustment on the input tuning condenser would then be necessary. It was found more convenient to use a separate condenser as indicated in Fig. 3 for this purpose.

It is not overstating the case to say that the great strides made in stable H.F. amplification during the last year are, to a large extent, due to the advent of the screened valve with an interelectrode capacity of the order of one hundredth of a micro-microfarad or less. This progress has been greatly assisted by the design of highly specialised apparatus for measuring minute capacities. In the accompanying article an interesting description of such equipment is given.

It may be of interest to point out that whilst C_2 can obviously be made to equal C_{gs} in capacity, it will not usually include the H.F. resistance introduced by the valve, valve-holder, etc. The damping effect of C_2 on the input circuit of the amplifier will, therefore, be less than when C_{gs} is in circuit, and a larger output reading obtained. The magnitude of the reading for this adjustment is, however, immaterial, as will be explained later.

Description of Apparatus.

The complete circuit arrangement is given in Fig. 4. The H.F. oscillator needs no special description other than that it provided a constant high-frequency and output voltage across the coupling coil to suit the particular H.F. amplifier employed. The frequency actually used in these tests was 750 kilocycles. The variable condenser C was specially constructed for the tests. It consists of a brass tube as one electrode and a thin wire as the other, the capacity change being obtained by moving the wire along the axis of the tube and measuring the displacement on some convenient scale.

In this particular case the wire was coupled by an insulating link to the movement of a standard micrometer which not only provided a scale, but also gave a very fine and accurate adjustment. Fig. 5 shows the appearance of this condenser. The capacity change per centimetre of movement was calculated from the following equation:—$C = 1/2\left(\log_e \frac{R_1}{R_2}\right)$; where C is the capacity change per cm. length; R_1 is the radius of tube electrode, and R_2 the radius of wire electrode.

In constructing such a condenser, certain precautions are necessary:—

(1) The electric field between the electrodes must be confined inside the tube. This is effected by suitable external screening.

(2) The "fringing" capacity between the ends of the tube and wire must be practically constant over the working range of the condenser, and must also be small compared with the true radial capacity between wire and tube, i.e., the tube must be long and the axial movement of the wire a fraction of its length within the tube.

It will be understood that the adjusting mechanism must be insulated and well screened from both electrodes, whilst the earth capacity of the wire which projects outside the tube must be constant. The wire itself must also move without deviation along the true axis of the tube. The condenser shown in the photograph had a capacity change of 0.01075 cms. per revolution of the micrometer, and this was sub-divided to give a fine adjustment of 0.00043 cms. variation for 1/25th of a revolution.

The switch S_1 was of the so-called anti-capacity type, having the additional feature of a screening member

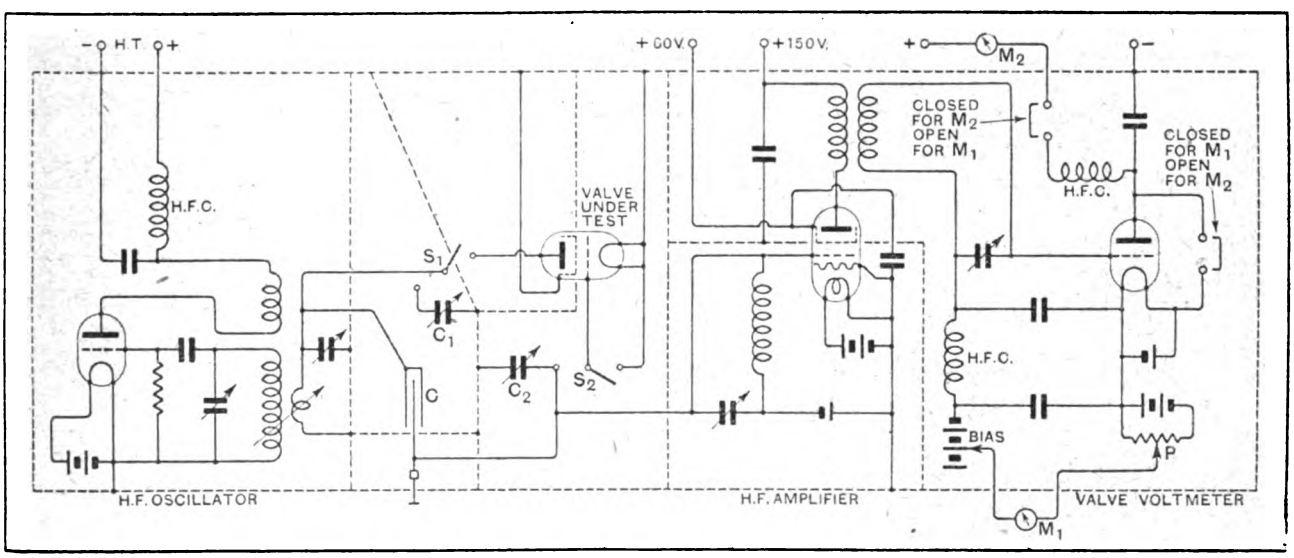

Fig. 4.—Complete circuit diagram of equipment containing essentially a valve voltmeter, H.F. amplifier, valve under test and an H.F. oscillator.

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Measuring the Interelectrode Capacity of Screen-grid Valves.—between the moving contact and the fixed contact which connects to the anode of the valve under test. A slit was cut in this screening member to allow of the passage of the moving contact. The mounting of the valve under test required some attention to ensure that all the electrostatic coupling between anode and control grid was inside the valve. In practice, a metal partition is usually provided with a circular hole through which the valve is inserted, thereby screening the wire connection to the anode from that to the grid. In the present arrangement a double screen was provided to allow valves of differing lengths being used without alteration to the screening.

Certain types of valves, similar to the Hull construction, require an earthed metal screen over the entire bulb. In fact, the capacity C_v can be reduced to some extent in any valve by completely covering the bulb with tin-foil and earthing it. The external screen apparently neutralises the coupling effect of the magnesium coating inside the bulb, which may, in some cases, extend from the anode terminal round to the pinch to which the control grid is anchored. In some types of screen-grid valve the magnesium coating is earthed by the makers. When this is the case, an external bulb screen, as distinct from partitioning screen, will obviously be superfluous. The radio-frequency amplifier consisted of only one tuned H.F. stage and employed a Cosmos AC/S valve, which enabled a circuit amplification of well over 100:1 to be obtained. A multi-stage aperiodic amplifier would have certain advantages over the tuned type, providing the overall amplification was of the order mentioned. The indicating meter M_1 was a microammeter in series with the grid circuit of a negatively biased triode, and not only served as an indicator but also measured the voltage developed across the tuned circuit by noting the bias voltage required just to bring the meter pointer to zero.

A more sensitive indicator was found desirable when measuring valves of the smallest capacity, and this was provided by connecting the same or another microammeter M_2 in the anode circuit of the triode. This latter arrangement does not give a direct voltage reading without calibration, but removes the damping on the tuned output circuit by eliminating the necessity of grid current flow through M_1. A greater output voltage will, therefore, result, apart from the added μ of the triode. The potentiometer P was used for adjusting the meter to some convenient setting on its scale whilst making the measurements.

Method of Operation.

The amplifier was tuned to the frequency of the oscillator and adjusted so that the maximum output voltage and negative bias could be used on the valve voltmeter without overloading the H.F. amplifier. This was done with switches S_1 and S_2 closed to include the valve coupling capacity C_v, *i.e.*, S_1 upwards and S_2 to left-hand contact. The next step was to adjust C_1 to the value of C_{as}. With S_1 closed to the anode (upwards) and S_2 on the right-hand contact, condenser C_2 was increased to replace C_{gs} until substantially the same meter reading was obtained. Switch S_1 was then closed to C_1 (downwards) and C_1 adjusted until the same meter reading was shown. This gave the correct setting for C_1 as a substitute for C_{as}. S_2 was then closed to the left and C_2 reduced to zero or to its original setting. The meter reading was now noted. Switch S_1 was now thrown up, putting the valve capacity C_v in parallel with C, which was reduced until the previously noted reading was again obtained. The value by which C had to be changed gave the required capacity of the valve.

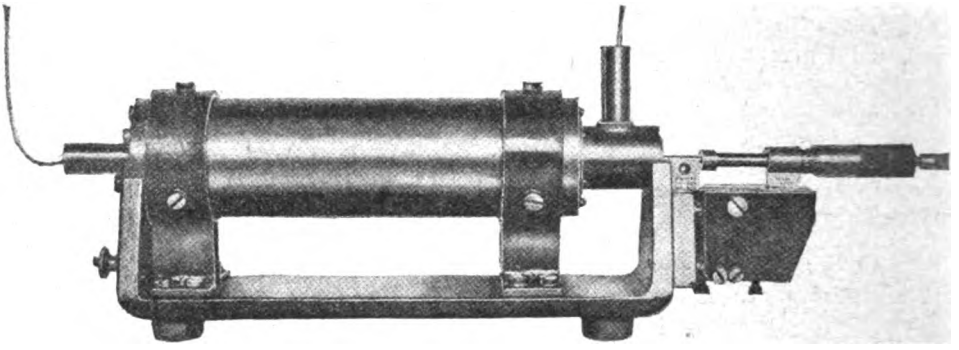

Fig. 5.—Standard micrometer condenser. The illustration shows the chassis supporting the condenser, and micrometer adjustment. The wire and tubular electrodes are inside and concentric with the screening tube seen in the photograph, and the terminal connections to the condenser are indicated by the two wires which project through the smaller screening tubes.

Precautions were found to be necessary, as erratic or

TABLE I.

Valve.	No.	Capacity ($\mu\mu$F).
Mazda 215SG	1	0.0085
	2	0.0086
	3	0.0072
	4	0.0067
	5	0.0072
	6	0.0089
Cosmos AC/S	1	0.0072
	2	0.0072
	3	0.0067
	4	0.0076
	5	0.0074
	6	0.0065
U.S.A. Hull Type	1	0.012
	2	0.012
	3	0.010
Hull Type AC/S	1	0.0095

Since the capacity measurements shown in the above table were taken, the Mazda 215SG and the Cosmos AC/S (now called the Mazda AC/SG) valves have been altered in construction and the interelectrode capacities have been reduced respectively to 0.005 cms. and 0.0045 cms.

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Measuring the Interelectrode Capacity of Screen-grid Valves.—inconsistent readings are sometimes caused by high resistance paths between the various electrodes inside the valve, and may even prevent the capacity of the valve being measured. It was, therefore, found advisable to subject each valve to a high voltage insulation test between the different pairs of electrodes before capacity measurements were attempted.

Results Obtained.

A large number of valves have been tested with the apparatus described, covering values from 0.100 cms. to 0.0017 cms. capacity, the accuracy obtained on the lowest figure being within 10 per cent. Table I gives results of measurements made on stock Mazda and Cosmos valves, and includes also capacities of some American type valves which may be of general interest.

An important point in connection with screen-grid valves which does not appear to be generally realised is that the interelectrode capacity should be reasonably uniform between different valves of the same make and type, otherwise when a valve is replaced instability may result.

In conclusion, it may be stated that capacity measurements have been made also on other types of valves mentioned by Mr. Bligh, the results on which agree generally with his. In fact, a method similar to his has been tested, using only 100 volts input and employing a calibrated R.F. amplifier voltmeter to compensate for the low output voltage. The writer is grateful to Mr. R. C. Clinker for his useful advice regarding the construction of the standard condenser, and has to thank the British Thomson-Houston Company, Ltd., for permission to publish the results of the work done in the Engineering Laboratory at Rugby.

NEWS FROM THE CLUBS.

A Record Junk Sale.

An exceptionally large number of components were disposed of at the Junk Sale organised by Slade Radio (Birmingham) at their last meeting. The Society is now appealing for more members, and it is thought that there must be numbers of enthusiasts in the Birmingham district who may be unaware of the Society's existence. Application for particulars should be made to the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

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Stations While You Wait.

An entertaining demonstration was given before the South Croydon and District Radio Society on November 19th, when Mr. Taylor, a former member, showed the capabilities of the Philips All-Mains 4-valve set. Scarcely a station named by members proved out of reach of this fascinating receiver, its only apparent shortcoming being its inability to receive signals without an aerial. It was shown, however, that even the merest apology for an aerial would suffice, as, indeed, was proved when the chairman himself touched the aerial socket and provided the audience with the pick of Europe's radio! The receiver embodies two screen-grid H.F. valves, leaky grid detection, and a pentode stage to the loud speaker, all valves being indirectly heated by A.C.

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

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New Society in Essex

The opening of the new Brentwood and Warley Wireless Club was celebrated in an auspicious manner on Wednesday last by a public debate on "The Merits and Demerits of the Brookmans Park Transmitter," which showed that the first of the regional stations is a subject of great interest to listeners in Essex.

New members will be warmly welcomed.

The Hon. Secretary of the Brentwood Club is Mr. M. B. Edwards, 38, Junction Road, Brentwood.

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How Metal Rectifiers Work.

A cinematograph display illustrating the use of metal rectifiers was given in the course of a lecture before the Kensington Radio Society on November 14th by a representative of the Westinghouse Brake and Saxby Signal Co., Ltd. At th Society's meeting on December 12th Mr. R. Waldo Emerson will demonstrate a 6-valve receiver. The meeting will be held at 8.30 p.m. at 20, Penywern Road, S.W.5.

Hon. Secretary, Mr. G.-T. Hoyes, 71a, Elsham Road, W.14.

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Valve Mysteries Explained.

Valuable technical data regarding the design of radio valves was given at the meeting of the Muswell Hill and District Radio Society on November 20th by a representative of the Mullard Company The fundamental principles of the screen-grid and pentode valves were described, and members received some useful hints which cleared up several mysteries.

Hon. Secretary, Mr. C. J. Witt, Coniston Road, Muswell Hill, N.10.

Set Wiring Explained.

The Queen's Park and District Division of the Wireless League are resuming their series of monthly meetings on Thursday, December 5th, at 8 p.m., when it is hoped to demonstrate the wiring up of a well-known radio receiver. Amateurs are cordially invited to attend these meetings, which will be held on the first Thursday in each month at 37, Enbrook Street, Harrow Road, W.10.

Full particulars of these and other interesting events gladly supplied by the Local Secretary, Mr F. Batho, at the above address.

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Sets of the Future.

Mr. Haynes, Assistant Editor of *The Wireless World*, recently lectured before a large audience of members of the Wembley Wireless Society, taking as his subject the question of selectivity.

In view of the interference now experienced from the new broadcasting station at Brookmans Park, Mr. Haynes's remarks were most helpful. Valuable suggestions were made for the cutting out of this station and receiving other stations quite near in the wavelength scale.

The lecturer also touched briefly on the forthcoming design of sets and outlined the modifications which will take place next year. From Mr. Haynes's remarks it was clear that we have not yet reached finality in the design of wireless receiving sets, and in the future their design and construction will call for considerable ingenuity from a mechanical as well as an electrical point of view.

Hon. Secretary, Mr. H. E. Comben, 24, Park Lane, Wembley.

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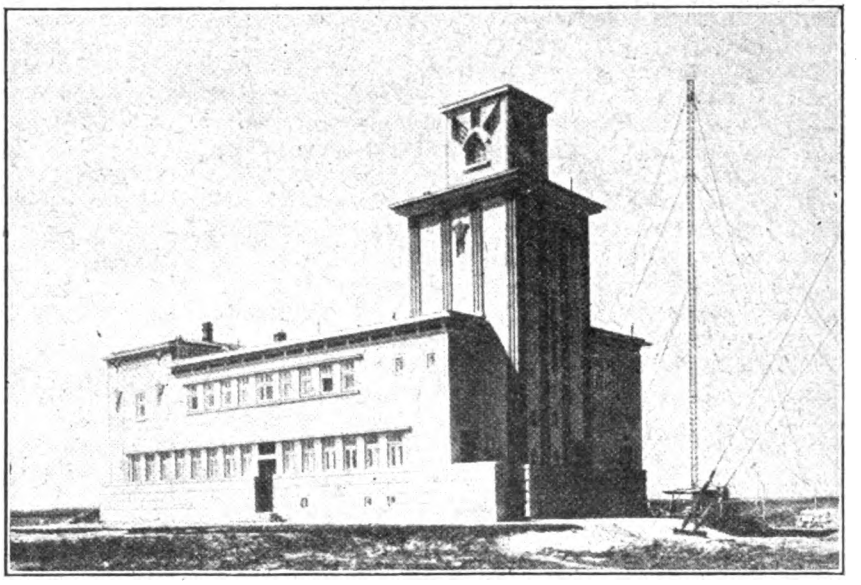
Anode Converters.

Anode converters and motor generators as applied to wireless and gramophone amplification were discussed by Mr. Woodall, A.M.I.E.E., of the M-L Magneto Syndicate, at a recent meeting of Slade Radio (Birmingham). A number of anode converters, rotary transformers, and motor generator sets were on view. The evening concluded with a demonstration given with the assistance of the Radio Gramophone Development Co., who kindly supplied the necessary apparatus.



RADIO AND THE ARCHITECT.—Broadcasting has given architects a new outlet for original expression. The building shown above houses the Bucharest transmitter, which provides Hungarian listeners with all-day programmes on 550 metres. The power is 20 kW.

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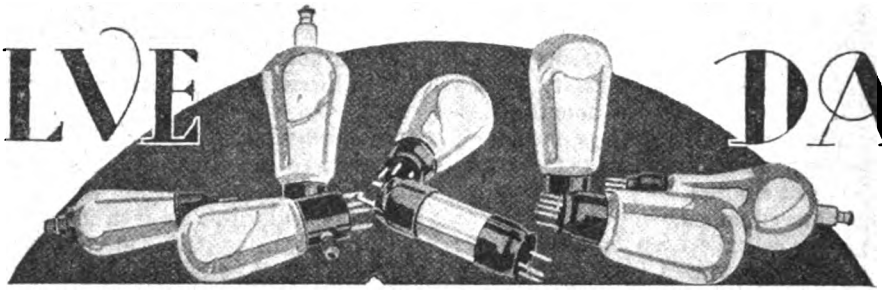
VALVE DATA



Interpreting the Information given in "The Wireless World" Valve Data Sheet.

PROGRESS in receiver technique depends to a large extent on progress in valve design. The set is built around its valves, and the hope of really successful performance can only be fulfilled if the various valve constants now so willingly given by the manufacturers are understood and applied to the best advantage. The separate valve data sheet accompanying this issue is wider in its scope than that which we published in February of this year. In it there are about 165 representative British valves classified under five main headings—a step rendered necessary by the growing list of special-purpose valves, no two classes of which can be easily categorised under the same sub-headings. It is the aim in these notes to explain briefly the various data in each section which will be taken *seriatim*.

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THE supplementary valve data sheet which accompanies this issue contains a number of important new features which are the subject of discussion in these notes. The publication of the A.C. power output in milliwatts of some 85 valves should make the scientific design of the output stage of an amplifier considerably easier. The degree of unobjectionable distortion which is permissible is taken as 5 per cent. second harmonic. The tabular matter giving the maximum possible stage amplification of screen-grid valves taking into account interelectrode capacity will undoubtedly prove of assistance in constructing H.F. amplifiers. All symbols and formulæ used are explained in the appendix at the end of the article.

Screen-grid Valves.—Certain data such as filament volts and amps. are omitted as they are obvious in nearly every case from the type name. The best performance will be obtained with the maximum anode and screen voltages specified, but anode voltages down to about 100 minimum may be used with a slight reduction in screen volts. Anode voltages below this figure may bring the operating point to the negative resistance "kink" in the characteristic which will result in uncontrollable oscillation.

A knowledge of anode current is necessary when it is desired to reduce the voltage from an H.T. eliminator. The value of the voltage-dropping resistance required, for instance, to feed the anode of a Marconi S.410 valve with 150 volts from an eliminator giving 230 volts is $230-150 \div 3.8$ mA. (expressed as amperes) $= \frac{80}{0.0038} =$ 20,000 ohms approx. The average anode current figures given assume maximum anode voltage, optimum screen volts, and 0.9 volt negative bias for battery-fed valves and 1.5 volt bias for the indirectly heated A.C. type. There is very little "straight" portion in the grid volts-anode current curves of a screened valve—the mutual conductance and hence signal strength increasing as the signal is impressed nearer and nearer to zero grid volts.

Taking into account the large H.F. stage gains now obtained and the limited grid swing acceptance of the detector, it is safe to allow about $\frac{1}{5}$-volt as the largest signal which the valve preceding the detector will have to handle. The bias need not exceed a fraction of a volt provided that no grid current flows at zero grid volts. This condition obtains in the battery-fed S.G. valves, and a bias of 0.9 volt is given as being conveniently obtainable from the special battery developed by Messrs. Siemens for *The Wireless World*. With indirectly heated A.C. valves, due chiefly to the fact that there is no voltage difference between the ends of the emitter, grid current may flow when the grid is quite a large fraction of a volt negative and a bias of $1\frac{1}{2}$ volt is desirable.

Screen current is not published, as it would be unsatisfactory to obtain screen potential from a considerably higher voltage source by the use of a series resistance. A potentiometer should be employed passing 2 to 3 mA., which is about four times the screen current of an average S.G. valve. Mutual conductance is omitted in favour of an H.F. performance factor given by $\frac{\mu}{\sqrt{R_a}} \times 100$. This shows a true figure of merit for an H.F. valve used with an H.F. transformer of optimum ratio. For a given signal a valve with a performance factor of 80 will give twice the H.F. output as compared with one having a performance factor of 40. If a *Wireless World* type of transformer wound with Litz on a 3in. former with a fine wire primary is used as an inter-valve coupling—and such is to be recommended on the score of stability when the receiver is mains driven, it can be assumed that the dynamic resistance R of the secondary is about 250,000 ohms. The optimum transformer ratio is $\sqrt{\frac{R}{R_a}}$, which in the circumstances becomes 500 divided by the square root of the valve's A.C. resistance. Where the valve has a greater A.C.

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Valve Data.—

resistance than 250,000 ohms and a step-down ratio is theoretically correct, a 1 to 1 ratio is specified in the tables as being a compromise between tolerable selectivity and signal strength. The stage amplifications attained when using optimum transformer ratios are given by the expression $\frac{1}{2}\mu$ N, but in nearly every case the figure exceeds the limit of stable amplification possible (compare cols. giving stage amp. neutralised and max. stage amp. unneutralised). This means that there are only one or two screened valves on the market which will not oscillate when used with a *Wireless World* type of transformer of *optimum ratio* unless neutralised.

Where selectivity is of the utmost importance, amplification must be sacrificed by using fewer primary turns on the transformer than are dictated by theory When a 3 to 1 transformer, for instance, of the type already mentioned is used, stage amplification is given by $\frac{N\mu R}{R+N^2R_o}$ and the results are given in the last column but one. The figures do not reach the limit of stable amplification, and neutralisation is therefore unnecessary. From this it will be seen that the removal of primary turns is conducive to greater stability and better selectivity, but signal strength is reduced.

We now come to the constant which makes or mars the screen-grid valve from the point of view of maximum stable amplification, namely, residual anode-grid capacity. By the expedient of arranging two screening grids in cascade or by using a cross-mesh screen the interelectrode capacity has been reduced in two or three cases to the low figure of approximately 0.005 $\mu\mu$F. Expression (a) in the appendix gives the maximum possible amplification before oscillation sets in due to the feed back through the small condenser formed by the grid and plate of the valve. This formula is solved for practically all the screen valves shown, and the figures obtained are given under the heading—Max. stage amplification unneutralised—which is next to the anode-grid capacity column. As an example of the influence of interelectrode capacity it will be seen that the Mazda 215 S.G. valve has a stable amplification of 153 with a capacity of 0.005 $\mu\mu$F.; had this been 0.05 $\mu\mu$F.—still a very low figure—expression (a) shows that the amplification would drop to 60—rather less than that of the best neutralised triode. It is claimed that if copper gauze of fine mesh be wrapped round the bulb of the MS4 valve and earthed, the internal capacity is reduced from 0.0045 $\mu\mu$F. to 0.0025 $\mu\mu$F., provided that the valve is already contained within a screening compartment. This would increase the maximum unneutralised amplification to considerably over 200 times.

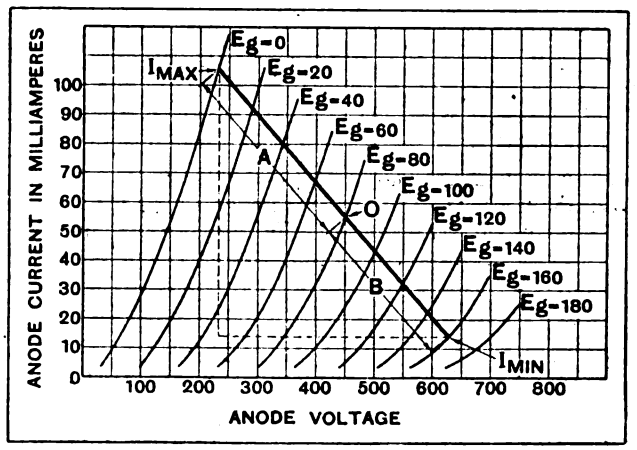

Fig. 1.—Anode volts–anode current curves for equal increments of grid voltage for a super-power valve. By pivoting the 5 per cent. second harmonic scale at the operating point O, the optimum load line (i.e. loud speaker impedance) and the power output triangle can be found for allowable distortion.

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Miscellaneous Valves.—From these three-electrode valves having A.C. resistances greater than 13,000 ohms will be chosen the neutralised H.F. valves, certain anode and grid detectors, and early L.F. valves. As explained in the screen-grid section, if a *Wireless World* type of H.F. transformer is used the step-up ratio is obtained by dividing 500 by the square root of the valve's A.C. resistance. As an example let us take the Mazda AC/HL; the step-up ratio would be $\frac{500}{\sqrt{13,500}}=4.3$ and the stage amplification $\frac{1}{2}\mu N=\frac{1}{2}\times 35\times 4.3=75$. Similarly the Osram H.L.610 would require a step-up ratio of $\frac{500}{\sqrt{30,000}}=2.9$ and the stage amplification $=\frac{1}{2}\times 30\times 2.9=43$. It would be as well not to choose a valve for this function that has an H.F. performance factor $\left(\frac{\mu}{\sqrt{R_o}}\times 100\right)$ less than 14. The grid bias given is for amplifying conditions, and should be doubled for anode bend detection using the same anode voltage. The average anode current figures are useful for calculating voltage dropping resistances when deriving current from the mains as explained earlier.

Anode bend detectors can be of two distinct classes; first, those chosen from among valves having A.C. resistances greater than, say, 15,000 ohms, which can only accept peak voltages of 2 or 3, and must be followed by resistance coupling, and secondly, those with A.C. resistances less than 10,000 ohms which will accept peak voltages up to, say, 10, and can be followed by an L.F. transformer provided that its primary inductance is of the order of 150 henrys under working conditions. The first type will be found among the valves under discussion, and will not throw any appreciable load on the

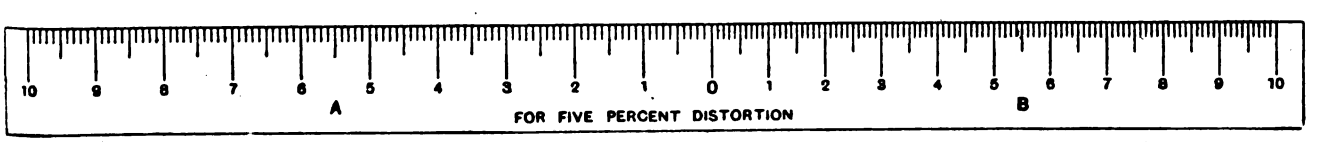

Fig. 2.—The 5 per cent. second harmonic distortion scale. The divisions on the left of zero are 11/9ths those on the right.

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Valve Data.—

preceding tuned circuit, while the second type must be selected from the Output Valve section, and will load the tuned circuit to a certain extent. Suitable valves for this latter class are those having mutual conductances of about 2 and A.C. resistances of about 8,000 ohms.

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Output Valves.—This section contains valves with A.C. resistances less than 13,000 ohms, and as in the last series the grid bias figures are for amplifying conditions. The maximum undistorted output requires some explanation. This constant is extremely valuable in designing output stages under correct load conditions, and it is hoped that by the time our next data sheet is published the valve manufacturers will have agreed upon a standard basis of measurement. The figures given must be considered as a useful guide, but because two valves of obviously similar characteristics made by two different firms differ by, say, 10 per cent., the valve with the *slightly* higher output must not necessarily be considered superior. Valve makers differ in their method of fixing the bias point, there are indications in some cases of rather high biasing to obtain low anode currents; this contributes towards a slight disparity between valves of otherwise similar constants. A moving coil speaker for home use requires approximately a minimum of 1,000 milliwatts to give satisfactory volume, for public address work and large halls 5,000 milliwatts upwards is necessary, while a small cone loud speaker would give very good volume if it were fed with 500 milliwatts, and all the power that a portable set can give its loud speaker when 2-volt valves are used with 100 volts H.T. is about 150 milliwatts.

The graphical method of arriving at power output is probably the most accurate; it is, however, rather too laborious when 85 valves have to be examined! Typical valves of different classes have been checked by this method, and have been found to give sensibly the same figures as those derived from expression (b) in the appendix which has been used for column D. The graphical method which it is hoped will become standard is clearly described by K. S. Weaver in the November, 1929 issue of *QST*. The anode current-anode volts curves at a number of fixed grid voltages differing by equal increments are plotted as in Fig. 1. A scale is then made as in Fig. 2, such that each division on the left of 0 is $\frac{11}{9}$ths that of each division on the right. The point of maximum anode current and voltage gives the operating point O on one of the grid voltage curves, and it now remains to pivot the zero of the scale on the operating point to obtain the best angle (load line or optimum loud speaker impedance) at which the scale gives the same reading on either side of zero where two grid voltage curves are cut. Each of these curves must represent equal voltages either side of the operating grid voltage. For example, in Fig. 1 when the zero on the scale is pivoted at the operating point O on the grid voltage of 80, 10 on the left of zero will cut Eg = 0, while 10 on the right cuts Eg = 160 if the scale is held at the angle shown. In fact, A in Fig. 1 will be $\frac{11}{9}$ths of B.

It will be noted that the distance between Eg = 160 and Eg = 140 is less than that between Eg = 0 and Eg = 20[1], and as the anode voltage swings up and down the load line, second harmonic distortion will take place. It is generally agreed that 5 per cent. second harmonic is the maximum unobjectionable distortion permissible. The scale in Fig. 2 obtains the necessary load line for this condition, and if the dotted sides of the triangle shown in Fig. 1 are multiplied together as volts × amps. and divided by 8 the resultant figure is the A.C. power output in watts for 5 per cent. second harmonic distortion. Expression (b) in the appendix which is due to B. C. Brain[2] arrives at the same result from purely mathematical considerations. The mutilating effect on a pure sine wave by superimposing a second harmonic[3] (twice fundamental frequency) of 50 per cent. amplitude is shown in Fig. 3. The case is, of course, exaggerated, but the ear can detect 5 per cent. distortion more easily than the eye. It is often suggested that the D.C. anode dissipation (i.e., col. A × col. C) multiplied by 0.2 will give the maximum A.C. watts, but different classes of valves require a different factor —one must look up the answer first and then work out the problem!

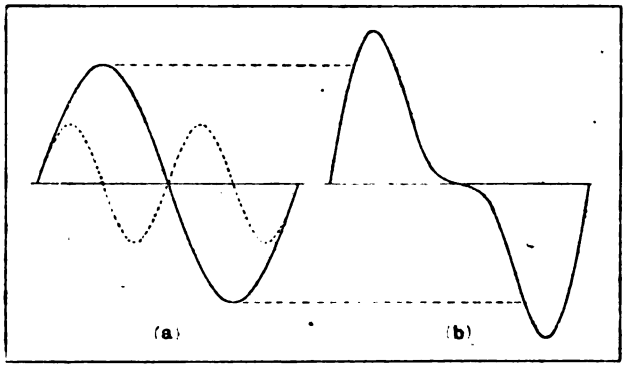

Fig. 3.—Second harmonic distortion. (a) Sine wave representing the fundamental and a 50 per cent. second harmonic (in dotted lines). (b) The two waves in (a) combined to form a distorted wave.

In comparing power output figures it is only fair to examine the grid bias (col. B) to see what input is necessary, it is also interesting to note the anode voltage required. The PX4, P650 and the AC/P1 should give adequate volume with a moving coil loud speaker using only 200 volts H.T. An interesting point is brought forward in the article by B. C. Brain, namely, that the power output is proportional to the 2.5 power of the anode voltage. That is, if the anode voltage is doubled the power output increases by $2\frac{1}{2} = 5.6$ times—the advantage of high anode voltages where these are possible is obvious. The output from two valves in parallel or push-pull is approximately double that of one valve provided that the load is halved and doubled respectively. There is a slight advantage in push-pull in that even harmonics tend to be cancelled out, but with mid-point biasing there is no serious gain.

[1] See article entitled "The Pentode under Working Conditions" elsewhere in this issue.

[2] See *Experimental Wireless*, March, 1929.

[3] See *Experimental Wireless*, July, 1926. Article entitled "Harmonics and their Effects on Wave Form," by J. F. Herd.

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OUTPUT VALVES

	Filament.	At Zero Grid Volts 100 Volts H.T.

Valve Data.—

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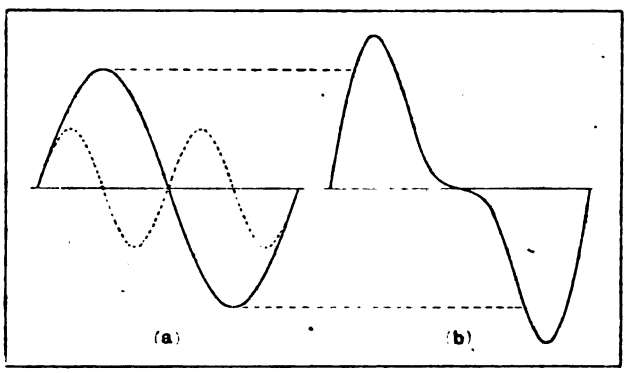

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OUTPUT VALVE

	Filament.	At Zero Grid Volts 100 Volts H.T.

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A 28

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Valve Data.—

Pentode Valves.—It should be noted that out of 15 valves, 6 require a screen voltage less than that of the anode. This suggests a resistance to drop the necessary volts, and at the same time to decouple the screen circuit. The value of the screen current which is necessary to calculate this resistance is given in col. F. Amplification factor and A.C. resistance are omitted as they change considerably with small alterations in screen and control grid voltages, but the mutual conductance, which is given, remains fairly constant. In any case the A.C. resistance of perhaps some 40,000 ohms is no guide to the speaker impedance which should be about 7,000 or 8,000 ohms to avoid distortion and dangerous over-voltages as explained elsewhere in this issue. The power output in col. D is obtained graphically from a family of anode volts-anode current curves, and the limiting condition of distortion in this case is the third harmonic which again has to be reduced to 5 per cent. to become unobjectionable. In Fig. 4 a third harmonic of 33⅓ per cent. amplitude (dotted curve) is shown combined with its fundamental. The resulting flat-topped wave (*b*) is particularly unpleasant. The formula in the appendix for power output cannot be used for pentodes. The enormous power output for small input grid swing is the feature of the pentode, as will be shown by an examination of the data sheet. There is an error in the valve data sheet in the pentode section; the grid bias sub-heading should read—for A and E—not—for A and C.

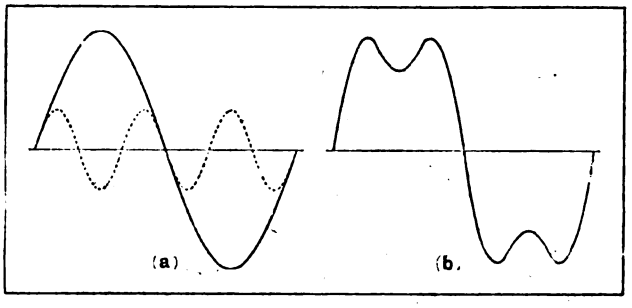

Fig. 4.—Third harmonic distortion. A wave of 33⅓ per cent. amplitude and of 3 times fundamental frequency when combined with its fundamental gives a particularly objectionable flat-topped wave (b).

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Rectifying Valves.—In choosing a rectifying valve it is necessary to have the maker's regulation curve to see what voltage will be available at the terminals of the filter with the known load of the receiver. Connected across the output of a rectifying valve there must be a condenser which it is understood has been standardised at 4 mfds. by the manufacturers. This condenser, which must be considered as part of the rectifier and not part of the filter, is necessary to improve power factor (rectification efficiency). The use of *considerably* more than 4 mfds. may damage the valve, while 2 mfds. would mean a reduced output. The reduction of rectified output must never be carried out by dimming the filament as this tends to saturate the valve and causes its early destruction; furthermore, the impedance rises and the regulation curve becomes steep. The absorption of excess volts should be carried out with series resistances and sub-potentiometers where the feeds are extremely small. The figures given for maximum unsmoothed D.C. assume a 4 mfd. shunted condenser, but allowance is not made for any drop in output due to the resistance of smoothing chokes.

APPENDIX.

Max. stage amplification (unneutralised) with S.G. valves before threshold instability is reached at 200 metres taking into account anode-grid capacity is given by

$$A = \frac{-1+\sqrt{1+2\mu R_0 \omega C_0}}{\omega C_0 R_0} \quad \ldots\ldots (a)$$

$$\text{Milliwatts output} = HK\mu\left(\frac{V_a}{\mu}\right)^2 \quad \ldots\ldots (b)$$

A = Stage amplification.
C_0 = Anode-grid capacity in farads.
μ = Amplification factor of valve.
R_0 = A.C. resistance of valve (ohms).
R = Dynamic resistance (ohms).
$\omega = 2\pi \times$ frequency (at 200 metres, $\omega = 10^6 \times 2\pi \times 1.5$).
N = Step-up turns ratio of H.F. transformer.
V_a = Max. anode volts.
E_g = Grid bias.
I_a = Anode current (mA.).
H = A coefficient depending upon the ratio of external to internal impedance in an output valve. If there is no watts dissipation limit, $H = 0.041$, but with large power valves the load impedance may have to be up to 4 times the A.C. resistance of the valve and H becomes a minimum of 0.032. See article by B. C Brain already referred to.
K = A constant obtained from the maker's valve curves.

$$= \frac{I_a}{\left(\frac{V_a}{\mu} - E_g\right)^2}.$$

V_a is obtained from col. A; E_g from col. B and I_a from col. C.

A COMPLETE INDEX TO RADIO LITERATURE.

THE December number of our sister journal, *Experimental Wireless*, completes the volume for the year, and contains an index to the technical articles on radio subjects which have appeared in all countries and in all languages during the past twelve months. From month to month *Experimental Wireless* issues with each number a service of abstracts and references to the world's wireless literature, and the December number contains the index to these abstracts for the year. The index is an invaluable source of information, especially to those who happen to specialise in the study of any particular branch of the subject.

In addition to this index, the December number contains an article on the design and use of a new type of valve voltmeter by Manfred von Ardenne, and a study of the effect of the ground on downcoming plane space-waves; there is also an important contribution by R. Wilmotte on "A Comparison of the Power Factors of Condensers."

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OPERATING FILTER CIRCUITS

Practical Hints on Applying an Improved Tuning System.

By H. F. SMITH.

BITTER complaints have already been registered by those whose long-distance reception has been eclipsed by the high-power transmissions from Brookmans Park, but it seems likely that the storm that has just subsided will renew itself with redoubled force when the twin station starts work. Over a wide area, listeners with out-of-date and unselective apparatus will find themselves in the unenviable position of being unable to receive even one programme without interference until their sets are altered.

Indignant listeners may even go to the length of demanding a refund of their broadcast licence fees, but it is certain that among the applicants there will be but few

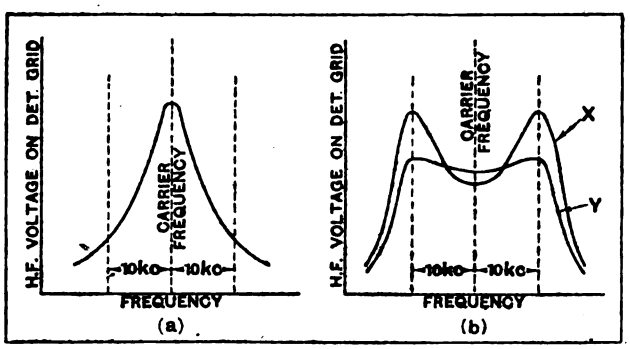

Fig. 1.—Resonance curve of conventional single circuit (a) compared with outputs obtainable from filter circuits.

Wireless World readers: to the true enthusiast, difficulties of this kind exist only to be overcome. Of the several possible lines of attack, none offers greater possibilities than the use of tuned filter circuits, which have already been discussed[1] at some length. It is suggested that an hour or two may profitably be spent in acquiring practical first-hand knowledge of the behaviour of these circuits in their simplest form before attempting to incorporate them in more complex and ambitious receivers. An attempt will be made in this article to show how apparatus already in the possession of the average set constructor may be pressed into service for setting up a receiver that will afford valuable experience, and, it is believed, convince even the most sceptical of the worth of this method of tuning.

Without retracing our footsteps over ground that has already been covered, the reader may be reminded that the kind of tuning we are now trying to avoid is that represented diagrammatically in Fig. 1 (*a*), which shows the response (or H.F. voltage output relative to the audio-frequency component or modulation of an incoming carrier wave) of an ordinary "good" tuned circuit under actual working conditions. By linking together two such circuits with very loose coupling, no improvement is effected with regard to high-note retention, but selectivity is vastly improved.

Flattening Out Tuning Peaks.

As coupling between the circuits is made closer, there is a tendency for the composite circuit to give a maximum response to two different frequencies, and it is this property that is so valuable as an aid to obtaining real selectivity combined with good quality. Tuning curves of the kind provided by this arrangement are shown in Fig. 1 (*b*). The first (X) is what may be expected of low-loss circuits. It is not ideal, as a little consideration will show that, assuming a perfect detector and amplifier to be operated from the voltages developed, there would be over-emphasis of the higher audible frequencies. In actual practice, this might well be unobjectionable, if only because it is hard to avoid some high-note loss in the amplifier, but, to be on the safe side, it is well to aim at something more like curve Y, which is afforded by circuits of average "goodness," used without any abnormal precautions to avoid incidental losses.

The advantages of what is sensibly a flat-topped resonance curve can be realised by careful operation of the circuit given in Fig. 2, which represents an anode bend detector, transformer-coupled to an output valve. This

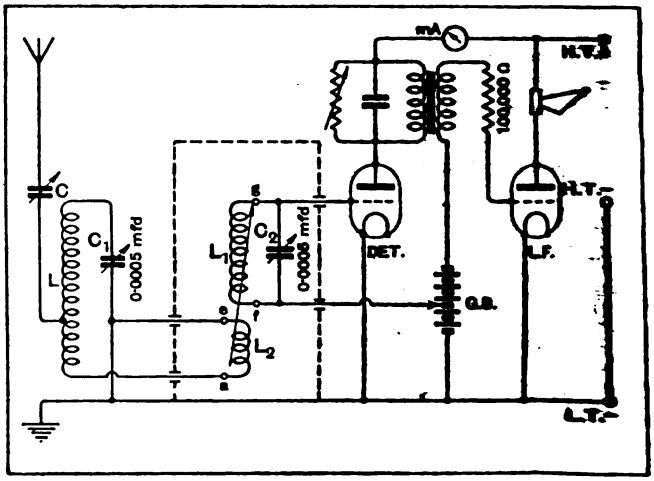

Fig. 2.—A simple local-station receiver for testing the effect of "double-humped" tuning. The anode bend detector valve should have a reasonably low impedance and an L.F. transformer with a large primary inductance should be used.

[1] *The Wireless World*, October 30th, 1929.

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Operating Filter Circuits.—

combination can give really good loud speaker signals at a distance of a few miles, and it is primarily suggested to those living within "good crystal range" of a broadcasting station. For our present purpose we are concerned mainly with the tuning circuits, and considerable latitude is permissible with regard to the L.F. amplifier; for example, resistance coupling will serve quite well.

The secondary inductance L_1 may consist of about 56 turns of No. 24 D.C.C. wire on a 3in. former. Its coupling coil L_2 may have some 8 turns of finer wire wound on a sleeve which is an easy sliding fit on the main former, so that its distance from L_2 (and consequently the coupling) may be readily adjusted. A sectional sketch of these windings is given in Fig. 3; connections are indicated by lettering corresponding with Fig. 2. A more convenient form of coupling (from the mechanical point of view) can obviously be devised by those with the necessary facilities.

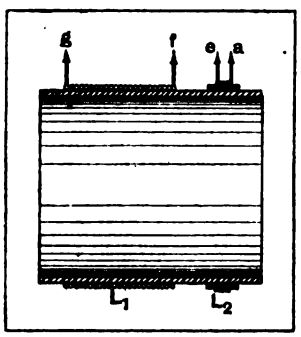

Fig. 3.—Construction of a coupler. Lettering of the terminal points refers to Fig 2.

Any reasonably good input coil (L) that is to hand may be used. Failing anything else, a winding similar to that specified for L_1, with a tapping at the 10th turn from the earthed end, will do admirably.

In order that inter-circuit coupling may be completely under control, the secondary winding and its coupling coil should be enclosed in a screening box, which may also accommodate the detector valve if space permits.

At very short range, some method of preventing detector overloading must be provided, particularly if the aerial system is efficient. A series aerial condenser (C) of some 0.00025 mfd., though not a perfect control, is effective enough, if one remembers that any variation in its setting will call for slight retuning. It is, perhaps, as well to state here that the whole essence of filter circuit operation is accurate tuning, and that the usual expedient of reducing incoming signal strength by detuning is quite out of the question.

Post-detection Volume Control.

Assuming that the input from the aerial is sufficient fully to load our detector, some means of preventing overloading of the subsequent valve must almost invariably be provided. For this purpose, a variable resistance of some 200,000 ohms may be connected across the L.F. transformer primary.

A sensitive milliammeter in the detector valve anode circuit is shown; this acts as an H.F. grid voltage indicator, and is a highly desirable refinement, but is by no means essential.

Having set up the circuit, local signals should first be tuned in accurately with the maximum possible separation between coils L_1 and L_2, making quite sure that there is no tendency towards double-humped tuning. If necessary, aerial input should be reduced, as it is much easier to work with a signal that is not overpoweringly strong. The setting of C_2 should be as critical as when "aperiodic" coupling is used, and a test may readily be made by temporarily joining the aerial to point *a* on L_2 after having removed the existing connection from this point. Coupling should be adjusted so that signal strength is changed as little as possible while making this comparative test.

Critical Adjustment of Coupling.

Reverting to the two-circuit tuner, we now come to the most critical operation—that of tightening coupling until the circuits begin to "pull" together and act as a true filter. If a detector anode meter is available, the simplest plan is to move the coupling coil towards the closed circuit winding until a maximum reading is indicated and then to make a further slight increase in the coupling until a definite but slight drop in current is registered. This is a sure indication that something approaching the desired results have been achieved, but a little experience is necessary to determine the best coupling for producing the proper degree of flatness. A good idea can be formed by noting the effect of rotating the condenser C_2; there should be little perceptible

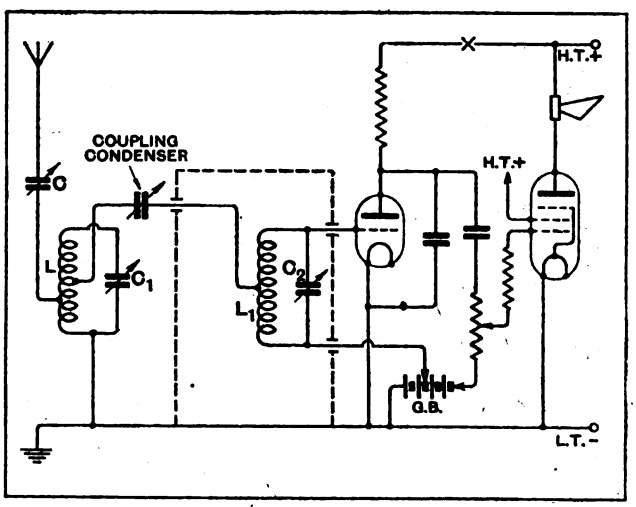

Fig. 4.—Another experimental receiver circuit with capacity coupling. A plate current galvanometer may be inserted at X.

change in signal strength (as indicated by the meter), as its dial is turned through at least a single scale division, or perhaps 2 degrees of a 0-180 scale.

If a meter is not available it is best to make progressive increases in coupling, "feeling" at each step for the desired broadening of tuning. In any case, it is essential that the variable condensers should be finally set exactly "in the middle of the signal," if the full benefit of a filter circuit is to be retained.

Where high selectivity is required, it is often necessary to adjust coupling so that the tuning curve "peaks" are rather closer together than shown in Fig. 1(b); in any case it is necessary at least to make provision for doing so when we come to deal with a long-range receiver with H.F. amplification.

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CURRENT TOPICS

Events of the Week in Brief Review.

THE ROYAL CONSTRUCTOR.

H.R.H. the Duke of York is reported to have completed the construction of a wireless set in his "workshop" at 145, Piccadilly.

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NEARING THE THREE MILLION MARK.

In the House of Commons last week the Postmaster-General reported that the number of broadcast licences now issued was 2,869,000. The number was increasing, and he was confident that it would reach 3,000,000 before very long.

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THE ALL-SEEING EYE.

A wireless "pirate" fined at the Thames Police Court asked if he could be informed of the names of the people who gave information about him.

Magistrate: You are not entitled to the information, and you must assume that there is an all-seeing eye which sees these things.

INVENTORS, FORWARD!

Louis Graveure, a Berlin concert singer, is appealing to scientists to invent a means of broadcasting whereby the waves will only be available to subscribers.

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THE WIRELESS LEAGUE.

Members of the Wireless League are cordially invited to attend the annual general meeting, which will be held at the Royal Automobile Club, Pall Mall, S.W., on Friday next, December 6th, at 3 p.m. Sir Arthur Stanley will be in the chair.

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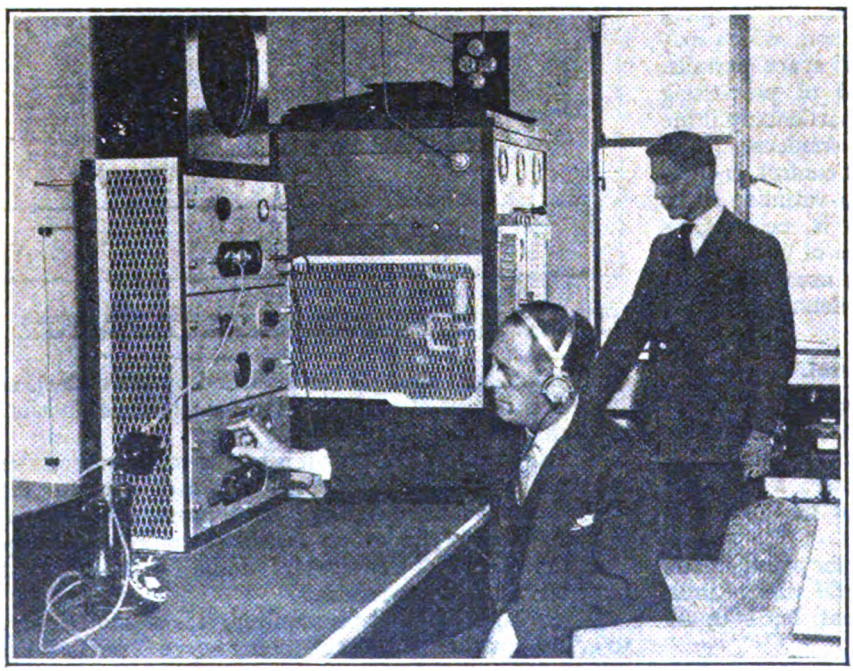
A NEW "KDKA."

KDKA, Pittsburgh, one of the pioneer broadcasting stations of the world, is to have a sister station at Saxonburg, Penn., early in 1930, according to the plans of the Westinghouse Electric Company. The new "KDKA" will concentrate on short-wave work, and for this reason the new site has been selected after an exhaustive search. The new station should make itself heard in Britain.



FLYING LESSONS BY WIRELESS. The new wireless installation at Heston Air Park School was officially opened last week by Sir Sefton Brancker, who is here seen adjusting the receiver. An illustrated description of the equipment appeared in "The Wireless World" of November 20th.

TONE CONTROL FOR ELECTRIC GRAMOPHONES.

Dr. N. W. McLachlan, M.I.E.E., F.Inst.P., will give a lecture, with demonstration, entitled "Experiments in Tone Control for Electric Gramophones," at the annual general meeting of the Incorporated Radio Society of Great Britain, to be held on Friday, December 13th, at 6 p.m., at the Institution of Electrical Engineers, Savoy Place, W.C.2.

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WIRELESS PRIZE HUNT.

An observation test of unusual interest will be provided in next week's *Wireless World* in the form of a Hidden Advertisements Competition. Wireless apparatus amounting in value to £20 will be offered to successful entrants, who will be able to choose their own prizes from goods advertised in that issue.

While calling for no technical skill, this intriguing test will challenge the competitor's powers of observation and his ability to make the best use of the clues provided. Full details will appear in our advertisement pages next week.

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RADIO SOCIETY'S HOSPITAL GIFT.

The Sheffield Wireless Society is presenting a broadcast receiving installation to the Firth Auxiliary Hospital for Women.

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A TECHNICAL TEST.

A Nottingham listener fined for owning and operating a set without a licence pleaded that he was only testing it. He admitted that he had committed a technical offence.

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WIRELESS FROM THE WILDS.

Short-wave wireless messages transmitted by Mr. Hinds for Major C. Court-Treatt, the British explorer, from a portable Marconi equipment in the wilds of Sudan, have been received as far afield as the United States of America.

Pitching their camps in the least-known parts of the Western Sudan, Major and Mrs. Court-Treatt and Mr. Hinds were able to maintain communication with Sudan Government wireless stations throughout their twelve months' travels in the jungle, where they were making the British Instructional film "Stampede."

Thus they were in regular touch with London through the Government stations and on a number of occasions their transmissions, on a wavelength of approximately 30 metres, were heard at a distance

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of more than 5,000 miles in Detroit, Michigan and Boston, Massachusetts.

The wireless transmitter used was a specially designed Marconi set of extremely small power and weight, the power being supplied by turning the handle of a small electrical generator.

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MUSIC WHILE YOU WAIT.

A Paris taxi owner has equipped his cab with a broadcast receiver. The loud speaker is in the roof and is said to drown traffic noises very effectively. Traffic blocks are forgotten.

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"SMALL ADS."

The return of the Christmas season makes it necessary to close for press earlier than usual with our issues of December 18th and 25th. Miscellaneous advertisements for inclusion in these issues can be accepted up to the first post on the Wednesday preceding the date of issue. Those for the issue of January 1st should be received not later than first post on Tuesday, December 24th.

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THE STENODE.

At a demonstration on Thursday last, Dr. James Robinson exhibited a receiver of his own invention in which high selectivity is sought by utilising only a narrow waveband. It is claimed that the apparatus is capable of receiving the modulated signal when sharply tuned to the carrier frequency, the audio frequencies being reproduced at their correct relative amplitudes. The device is called the Stenode.

The use of a narrow waveband has always been contrary to the views of *The Wireless World* as being inimical to quality reception; it is, therefore, possible that Dr. Robinson is making an original contribution of the first importance to our knowledge of the properties of resonant circuits. Some scepticism must prevail, however, pending the disclosure of precise technical details.

The device is understood to employ a quartz crystal resonator in conjunction with a superheterodyne which converts the original frequency to the natural frequency of the crystal. Dr. Robinson states that it is possible to restrict reception to a given transmission avoiding interfering frequencies as close as 100 cycles to that of the carrier.

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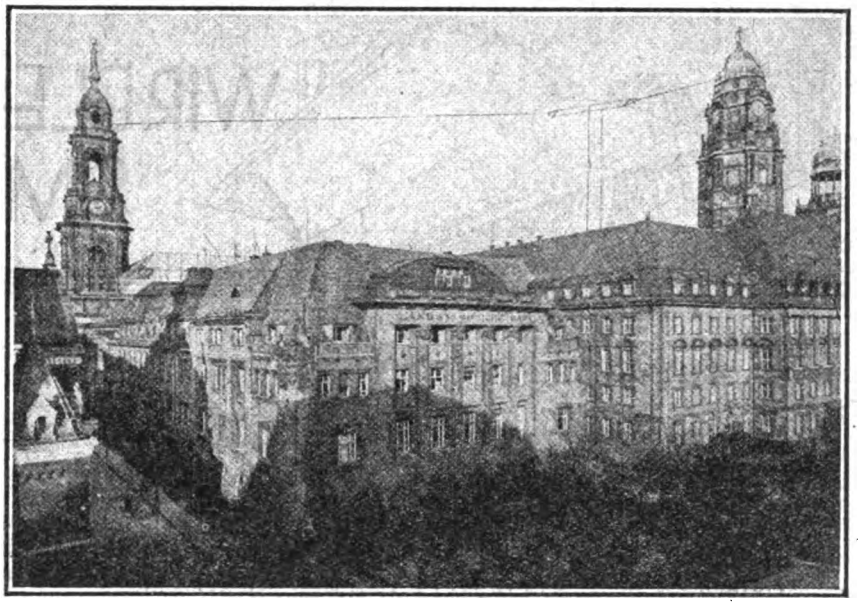
VALVE HOLDERS IN COURT.

In the Chancery Division of the High Courts of Justice on November 19th Mr. Justice Clausen delivered judgment in favour of the plaintiffs in the action brought by Benjamin Electric, Ltd., against Garnett, Whiteley and Co., Ltd. The plantiffs sued for infringement by the defendants of two patents, No. 222,086 (Benjamin Patent) and No. 240,918 (Burndept Patent), which relate to anti-microphonic valve holders. In delivering judgment, his Lordship said it became clear in the course of the case that if the plaintiffs' Patents, setting aside two claims in the Burndept Patent (which the plaintiffs asked leave to disclaim as separate claims), were valid, the defendants had infringed them.

On the question as to whether the defence of no subject-matter was to prevail, his Lordship said: "It was said that the plaintiffs' device (the Benjamin valveholder) is a combination of old features; and it may be true that each separate feature in the combination can be found in some previous device. It appears to me, however, that the combination of these separate features is not a mere juxtaposition of old features but has produced an article which operates as a whole and is a new and useful article."



DRESDEN'S AERIAL. The aerial system of the Dresden relay station overshadows the bank and municipal buildings. The station relays Leipzig on a wavelength of 319 metres.

FORTHCOMING EVENTS.

WEDNESDAY, DECEMBER 4th.

Institution of Electrical Engineers, Wireless Section.—At 6 p.m. At the Institution, Savoy Place, W.C.2. Lecture: "Naval Wireless Telegraphy Communications," by Mr. G. Shearing, B.Sc., and Capt. J. W. S. Dorling, R.N.

Edinburgh and District Radio Society.—At 8 p.m. At 16, Royal Terrace. Auction Sale.

Queen's Park Radio Society.—At 8 p.m. At the Oddfellows' Hall, 593, Harrow Road, Paddington. Lecture by Messrs. W. F. Floyd, A.Inst.P., and E. J. Reid, B.Sc.

Muswell Hill and District Radio Society.—At 8 p.m. At Tollington School, Tetherdown, N.10. Lecture and Demonstration: "The Elementary Principles of Television," by Mr. T. Andrews.

North Middlesex Radio Society.—At 8 p.m. At St. Paul's Institute, Winchmore Hill, N.21. Debate: "Is the Moving Coil Loud Speaker Worth While?"

THURSDAY, DECEMBER 5th.

Ilford and District Radio Society.—Lecture: "Operation from A.C. Mains," by a representative of the Marconiphone Co., Ltd.

FRIDAY, DECEMBER 6th.

Bristol and District Radio Society.—At 7.30 p.m. In the Geographical Lecture Theatre, University of Bristol. Lecture and Demonstration: "The Philips Four-Valve Set," by Mr. Cooper, of Philips Lamps, Ltd.

MONDAY, DECEMBER 9th.

Newcastle-upon-Tyne Radio Society.—At 7 p.m. In the Physics Theatre, Armstrong College. Demonstration of Commercial and Amateur Loud Speakers.

TUESDAY, DECEMBER 10th.

Ryde Radio Society.—Visit to the Sandown Radio Society.

WIRELESS AT WESTMINSTER.

(From Our Parliamentary Correspondent.)

A New Wireless Act?

During the Committee stage last week of the Expiring Laws Continuance Bill, Captain Bourne, a Unionist member, moved to omit from the scope of the Bill the Wireless Telegraphy Act of 1904. He explained that at the time the Act was passed no one dreamt that we should get the elaborate system of broadcasting that we had to-day. A new Act should be passed, he urged, which would bring the law up to date.

Replying to this and many other points raised, Mr. Lees-Smith, the Postmaster-General, said that there was to be a wireless international telegraphic conference in Madrid in two or three years, and that the conference was likely to adopt certain conventions which would need legislation in the Parliaments of the ratifying States, so that the Government might have to bring in a Bill on this subject in three or four years' time. They did not want two Bills.

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Brookmans Park Tests.

In regard to the experiments at Brookmans Park, said the Postmaster-General, the station was still working on a single wave, and the great change would come when it worked on the double wave, which would be initiated in a few weeks' time. It would not be initiated all at once, but probably it would be increased as the public accustomed itself to the new development. On the subject of television, he said that the Baird Television Company now had the right to use the B.B.C. stations for half an hour on five days a week out of broadcasting hours.

As to evasion of the payment of wireless licences, that was being gradually reduced.

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WIRELESS THEORY SIMPLIFIED

Part XI.

Capacity in A.C. Circuits.

(*Continued from page 600 of previous issue.*)

By S. O. PEARSON, B.Sc., A.M.I.E.E.

THE behaviour of a condenser in an A.C. circuit is one of the most important aspects of our subject. Inductance and capacity together constitute the key to all radio communication. To those studying the effect of capacity in an A.C. circuit for the first time, some of the facts come as a complete surprise and others prove most intriguing and interesting. For instance, when it is known that no current can possibly flow through a condenser from one set of plates to the other on account of the insulating medium between them, it may come as a surprise to learn that on an A.C. source of supply a lamp can be made to light when connected in series with a condenser. To those new to the subject or those who have given the matter no thought, this must appear to be a contradictory state of affairs, because apparently we have an alternating current flowing round a circuit in which there is a gap across which no current can pass.

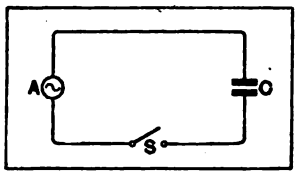

Fig. 1.—Simple circuit for connecting a condenser C across the terminals of an alternator A.

It is a very common practice to speak of an alternating current flowing *through* a condenser, but actually the current does not get through at all. It is only apparent. Our immediate object is to discuss this matter and see what really does happen.

It has already been shown that the rate at which the voltage between the plates of a condenser builds up is exactly proportional to the value of the charging current. If C is the capacity of the condenser in farads, the charging current at any instant is given in amperes by

$$i = C \times (\text{rate of change of voltage}) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

It will be realised that this relationship is of the same form as $e = I \times$ (rate of change of current) for an inductive coil, as explained in Part V (page 407), and we can therefore apply the same reasoning for determining the relationship between current and voltage when a condenser is connected to a source of A.C. supply.

Nature of the Charging Current

Suppose that a condenser of capacity C farads is connected through a switch S to the terminals of an alternator A as shown in Fig. 1. It will be assumed that the voltage at the terminals of the alternator varies according to the sine law so that when plotted as a curve to an angle base in the manner already described it gives a sine wave as shown by the full line curve of Fig. 2. Let E_m be the maximum value attained by the voltage every half cycle. Then the sine wave can be represented by a vector of length OE_m rotating about O at a speed of f revolutions per second, where f is the frequency. This means that the vector will have an angular speed of $2\pi f$ radians per second (see Part IV, October 16th issue).

Now suppose that the switch S is closed at an instant when the voltage is passing through one of its zero values and is increasing towards the positive maximum value. This instant is indicated by O in the graph of Fig. 2. Since the condenser C is now connected directly across the alternator terminals the voltage across it will be at every instant equal to the alternator voltage; and so, as the voltage rises, a charging current will flow round from one plate of the condenser to the other, being at every instant proportional to the rate at which the voltage is changing.

Clearly the voltage is changing at its greatest rate just as it passes through its zero values because the curve is steepest at these points. Therefore *the charging current will have its maximum value when the voltage is zero.*

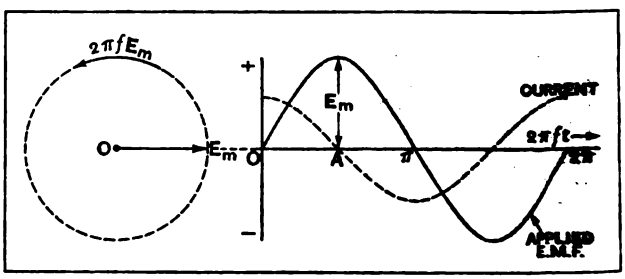

Fig. 2.—The speed of the end of the vector OE_m gives the maximum rate of change of voltage. The current taken by a condenser leads the applied voltage by a quarter of a cycle.

Just as the voltage is passing through its maximum value, it is neither increasing nor decreasing—its rate of change is zero—and therefore at this instant, denoted by A in Fig. 2, the condenser is being neither charged fur-

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Wireless Theory Simplified.—

ther nor discharged—the charging current is zero. Beyond this point, when the voltage starts to fall again, the condenser begins to lose its charge, showing that the current must have reversed and is therefore negative.

Obviously, since the condenser is being charged up in opposite directions alternately by the alternator, the electrons representing the charges will be surging backwards and forwards round the external circuit, being first piled up on one plate by the action of the alternator, then withdrawn and piled up on the other, and so on. But none of them passes through the insulation between the plates. This surging backwards and forwards of the electrons constitutes an alternating current and would be indicated by an ammeter in the circuit. It has its maximum value when the voltage is zero and falls to zero when the voltage is a maximum as explained above.

A Condenser takes a Leading Current

We conclude then that the charging current is an alternating one *exactly a quarter of a cycle out of step* with respect to the voltage. Furthermore, this current will have a *positive* maximum value when the voltage is zero and increasing towards the positive value. So the current can be represented by another wave in the position shown by the dotted curve of Fig. 2. From these curves we see that the current reaches its maximum positive value a quarter of a cycle *earlier* than the voltage and we arrive at the extremely important conclusion that a condenser in an A.C. circuit takes a current which *leads* the voltage by exactly a quarter of a cycle or 90°. This is just the reverse of a pure inductance, which was found to take a current *lagging* by a quarter of a cycle. This opposition of phase angles is one of the things which makes tuning possible.

No Power Consumed by a Perfect Condenser.

The average power consumed by a perfect condenser in an A.C. circuit is zero for the same reason as that given in connection with a pure inductance, namely that the current and voltage are out of step by a quarter of a cycle, the power factor being zero. The energy put into the condenser during the first quarter cycle when it is being charged up is all recovered during the second quarter cycle, during which time it is completely discharged again, and so on. In practice some very small losses occur in the di-electric and plates, but except in special circumstances this may be entirely ignored.

The condenser and alternator combination of Fig. 1 can conveniently be compared, for purposes of mechanical illustration, with a pump and divided air cylinder similar to that described in Part IX, but in this case the pump must be of a type designed to drive the air first one way through the pipe, and then the opposite way alternately.

A possible arrangement of this sort is indicated in Fig. 3, where C is the main air reservoir divided into two equal compartments by a diaphragm D, and P is a reversible air pump which is reversed at regular intervals. In this way air is first withdrawn from compartment A and added to that already in B, so creating a pressure difference or back pressure between the two sides. When the pump begins to slow down before reversing, the excess air in compartment A starts to flow back in exactly the same way that the condenser loses its charge when the alternator voltage is falling.

When the pump is reversed the pressure in compartment A falls below the normal and that in B rises, etc. And so as the pump is periodically reversed the air molecules will be surging backwards and forwards between the two compartments.

In exactly the same way the alternator may be looked upon as a sort of electron pump which causes some of the electrons in the circuit to surge backwards and forwards between the two plates of the condenser. A little

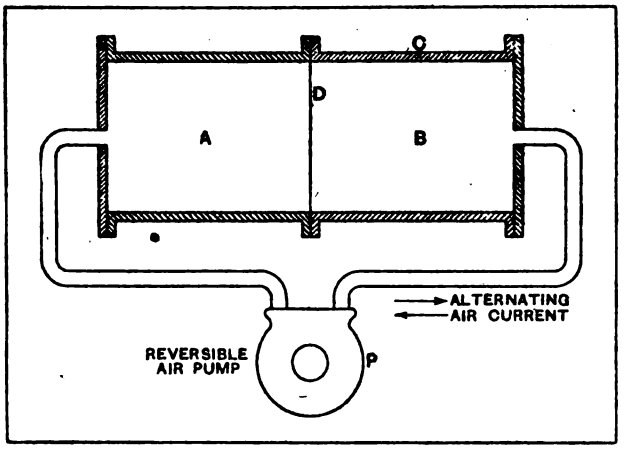

Fig. 3.—Divided cylinder and reversible air pump arrangement for illustrating the action of a condenser in an A.C. circuit.

consideration will show that the mechanical system and the electric circuit in question are also similar as regards stored energy, and as regards phase difference if we assume that the air pressure exerted by the pump obeys a sine law with respect to time. The current of air in the pipe stops flowing just as the pressure exerted by the pump reaches its maximum value in the same way that the charging current of the condenser ceases at the instant the alternator voltage reaches its maximum value.

Finding the Value of a Current.

Now that we know the phase relationship between current and voltage for a condenser we can find their relationship as regards magnitude, also by the aid of Fig. 2. The maximum value of the current will be $I = Cx$ (maximum rate of change of voltage) from equation (1) above. Now the maximum rate at which the voltage is changing is exactly equal to the actual speed of movement of the extremity of the vector OE_m, representing the E.M.F. wave as explained at some length on page 491 of October 30th issue in connection with the induced E.M.F. in an inductive coil. In the present case the speed, and therefore maximum rate of change of voltage, is $2\pi f \times E_m$ volts per second. Hence the maximum value attained by the charging current of the condenser will be:

$$I_m = C \times 2\pi f E_m = 2\pi f C \times E_m \text{ amperes.}$$

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Wireless Theory Simplified.—

But for sine waves the R.M.S. value is 0.707 of the maximum value, and so to get the R.M.S. value of the current we multiply each side of the last equation by 0.707, namely:

$$I = 0.707 I_m = 2\pi f C \times 0.707 E_m,$$

or $I = 2\pi f C \times E$ amperes,

where E and I are R.M.S. values.

Reactance of a Condenser.

It should be remembered that the ratio of E.M.F. to current in a circuit is always expressed in ohms, but whether this ratio gives resistance, reactance or impedance depends entirely on the phase relationship between the current and voltage. If they are in phase their ratio is a resistance, if they are a quarter of a cycle out of step their ratio is a reactance, and if they are out of phase by any odd angle between zero and 90°, i.e., if they are out of step by some fraction of a cycle less than a quarter, their ratio gives the impedance.

Now we have seen that for a condenser the current and voltage are exactly a quarter of a cycle, or 90°, out of step, and hence the ratio $\frac{E}{I}$ is in the nature of a pure reactance. And so the reactance of a condenser is given by $X_C = \frac{E}{I} = \frac{1}{2\pi f C}$ ohms, where C is the capacity in farads and f the frequency.

Comparison of Condensive Reactance with Inductive Reactance.

It is evident that both capacity and inductance in an A.C. circuit produce reactance; each of them introduces a phase displacement of a quarter of a cycle between the current and voltage. But in other respects they are fundamentally opposed: For instance, a condenser takes a current *leading* the voltage by a quarter cycle, whereas a pure inductance passes a current which lags behind the voltage by 90°. Hence if inductance and capacity are present simultaneously in the same circuit, one will have a neutralising effect on the other, and the results of this are to be discussed in the next part. On account of these opposing effects the reactance of a condenser must be considered negative with respect to that of an inductive coil when making calculations. To distinguish between them the one is called *condensive reactance*, and the other *inductive reactance*, denoted by X_C and X_L respectively.

Another aspect in which condensive reactance and inductive reactance are in contrast lies in the manner in which each depends on the frequency, and on the value of capacity and inductance respectively. Whereas inductive reactance is directly proportional to the frequency and inductance, being given by $2\pi f L$, the reactance of a condenser is inversely proportional to the frequency and capacity, being given by $\frac{1}{2\pi f C}$. This means that if an alternating voltage of constant R.M.S. value E is applied to a condenser of capacity C farads, the current "through" the condenser will be directly proportional to the frequency, and if plotted as a graph against frequency will give a straight line passing upwards from the origin O as shown in Fig. 4, where the reactance is also shown plotted against the frequency. These curves should be contrasted with those of Fig. 5 of Part VI (October 30th issue) for a circuit possessing inductance only.

Numerical Calculation.

From the results obtained so far we conclude that a condenser will pass no direct current at all but will allow alternating current to flow to an extent proportional to the frequency. As an example for numerical calculation we can take the case of a by-pass condenser connected between the plate and filament of the detector valve in a receiver. The object of the condenser is to provide an easy path to "earth" for the high-frequency component of the plate current, whilst at the same time preventing as far as possible the escape of the wanted currents of audible frequency.

Suppose that the by-pass condenser has a capacity of 0.0001 microfarad, the radio-frequency current has a frequency of 1,000,000 cycles per second (corresponding to a wavelength of 300 metres) and that the highest note frequency with which we are concerned is 5,000 cycles per second. In calculating the reactance the capacity must be expressed in farads, and is, therefore, $0.0001 \div 10^6$, or 0.0001×10^{-6} farad.

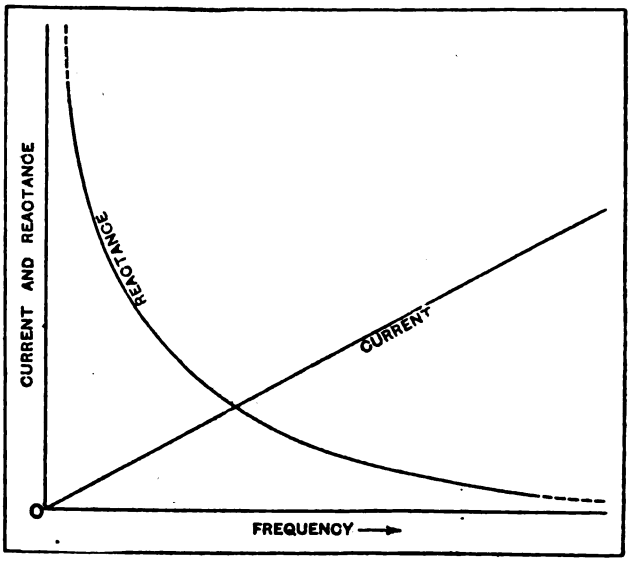

Fig. 4.—Curves showing how current and reactance vary with frequency for a condenser.

At a frequency of one million, or 10^6 cycles per second, the reactance is:

$$\frac{1}{2\pi f C} = \frac{10^6}{2\pi \times 10^6 \times 0.0001} = 1{,}590 \text{ ohms};$$

and at 5,000 cycles per second the reactance is

$$X_C = \frac{10^6}{2\pi \times 5000 \times 0.0001} = 318{,}000 \text{ ohms.}$$

Thus if there were an anode resistance of 150,000 ohms in the plate circuit, about 99 per cent. of the high-frequency current would be conducted away "through" the condenser, whereas only just over 30 per cent. of the audio-frequency current would be lost in this way.

The next instalment will deal with the effects of capacity in A.C. circuits where resistance and inductance are also present. (*To be continued.*)

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A New Problem and Some Suggested Solutions.

By F. H. HAYNES.

TROUBLE is certain to arise in a mains-operated set when the grid bias is produced by the inclusion of dry cells. We can be quite sure that the failure of the grid biasing cells will not be detected until impaired performance is suspected, by which time damage may have been sustained by the valves. Even in the battery-operated set the grid cells are neglected and in the mains set the possible existence of dry cells contained within the cabinet is entirely forgotten.

As an alternative to the use of cells, grid bias is derived by dropping part of the anode voltage across a resistance introduced into the filament (or cathode) side of the H.T. circuit (Fig. 1). This resistance, R, also forms part of the grid circuit, and the voltage set up across it is such that the filament is positive with regard to the grid or, taking the filament as being at zero potential, then the grid is negative. To determine a suitable value for this resistance it is only necessary to multiply the potential required by 1,000 and divide by the average anode current in milliamperes. As a rule only an approximate figure may be thus obtained, yet the result is sufficiently reliable and an error as high as 5 per cent. is not serious in view of the latitude in grid biasing values. It should be noted that the anode voltage is reduced by the amount of the grid bias taken, and for this reason it is not always economical to create in this way biasing potentials of 100 or more volts as required by super-power valves.

THE chief problem in the design of mains sets is that of providing "free" grid bias. Avoidance of feedback coupling as well as mains hum are the difficulties encountered. This article explains the development of receiver circuits in which bias for all valves is derived from a rectified anode current supply.

A resistance which forms a common path to both the grid and anode circuits of a valve produces a coupling between the output and input and may be responsible or contributory in the bringing about of instability in a high frequency amplifier or oscillation in a detector or low-frequency stage. This undesirable coupling is sufficiently removed by providing a path of low impedance to the signal currents across the biasing resistance by means of a shunt condenser. In a high-frequency circuit, including a screen-grid valve combined with coils of average resistance, a mica condenser of 0.01 mfd. should be regarded as the minimum capacity which can be safely adopted in a set tuning to both wavebands. For a low-frequency stage the shunt condenser will need to have a value of not less than 2 mfds. (Fig. 2). Coupling between grid and anode may be further localised in the case of a transformer-coupled L.F. or output stage by using a filter feed anode circuit. For example, a voltage drop from 300 to 60 as required by a leaky grid detector is produced by an anode resistance of some 60,000 ohms so that it becomes possible to feed the primary of the intervalve transformer through a condenser connected to the anode, thus avoiding incidentally an excessive current being passed by the winding. The earth side of the primary must now be returned, not to the common H.T. −, but to the filament or heater circuit. Similarly, in an output stage, the return lead of a filter-fed loud speaker, instead of connecting to the H.T. −, likewise runs direct to the filament. In this latter case it is advisable to connect condensers in each of the speaker leads, for it will be seen that an earth connection or low insulation occurring on the loud speaker winding would produce a short circuit across the resistance which gives the grid bias.

When dealing with indirectly heated valves it is at once obvious that a resistance connected in the cathode lead will give the required biasing potential (Fig. 3). It will also be noted that a common source of heater current may be connected to the several valves while the biases may differ. While such an arrangement will prove quite satisfactory with certain valves, instances may arise where mains hum is experienced, due to the difference of potential which has been set up between heater and cathode. Considering for a moment the actual circuit of a screen-grid H.F. stage biased in this way, it will be noted that while the dangers of grid-anode coupling across a common resistance are still present, there is in addition, a difference of voltage between heater and emitter, these being in intimate contact within the valve. Many indirectly heated valves may, however, be successfully operated in this way without trouble from A.C. hum, and in arranging the biasing resistance it will be found worth while to make it pass the current of the screen potentiometer as well as the anode current (Figs. 3 and 4). By so doing, the value of the resistance will be reduced owing to the appreciable increase in current which is necessarily passed by the potentiometer and a more constant value of bias will result.

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Main Sets and Grid Bias.—

Turning now to alternative circuits designed to avoid differences of potential between heater and cathode, it is pointed out that the use of a separate heater winding for each valve will prove inconvenient. In planning out a circuit one should start by joining the mid-point of the heater winding to a common return lead and to this lead also all the cathodes should be directly connected. As shown in Fig. 5, the grid biasing voltage is now produced across a resistance connected directly in the grid circuit, while no longer is the H.T.– taken to the common lead. Applying this principle to a tuned-grid circuit, it will be necessary to connect the resistance in series with the inductance while the tuning condenser may be taken from grid to earth (Fig. 6). The tuning condenser is shown in this way as in many sets its spindle will be common to other tuning condensers and will therefore be in contact through its bearings with the frame of the set. Further complication by way of the introduction of decoupling resistances has been omitted as it has been found in practice that the other factors present tending towards the setting up of self-oscillation are far greater in their effect than the common resistance with its by-pass condenser. It will be seen that this method can only be applied to two tuned stages when each requires the same bias. This is due to the biasing resistances being connected across common points in the circuit—the H.T.– and frame. Thus the biasing resistances are parallel-connected and the entire anode current of the stages will be distributed between them.

In an endeavour to devise yet another method, attention is turned to the possibility of passing the entire anode current required by the receiver through a resistance connected in the H.T. negative lead and stepping off biasing potentials as may be required by the various stages. Fig. 7 shows such an arrangement. By far the largest demand on the H.T. supply is made by the output stage, so that the omission of the detector and other amplifying stages from the circuit will not complicate a consideration of its principle. A correct grid bias, producing maximum signal, is obtained by the voltage drop across the resistance which, by way of example, has been shown having a value of 20 ohms. In addition to this resistance is a 250-ohm potentiometer from which the bias for an anode-bend detector may be obtained or, alternatively, such a potentiometer may serve as a volume control. By means of this potentiometer, therefore, grid bias applied to the H.F. valves may be steadily increased up to the point of extinction of the signal. A resistance of 0.5 megohm interposed in each lead, carrying the bias to the several stages is effective for decoupling purposes when associated with a fixed condenser of 0.01 mfd. Several bias values are available by making tappings along the resistance connecting the H.T.– to the common return lead, and if the potentiometer prevents the provision of a tapping at a particular voltage, then another resistance may be connected in parallel so as to provide a convenient point of sub-division. Where several chokes are used for smoothing purposes there is no objection to the resistance of one of the chokes being used as a means of producing bias.

A mains-fed anode-bend detector circuit is shown in Fig. 8, and here again suitable bias is produced by connecting to the point X a lead from the main biasing resistance. Leaky grid detection involves no problems as regards bias. It is only necessary to connect the leak to the cathode. When the grid current characteristic, however, reveals that a definite application of positive bias is necessary it is best produced by a connection to a high-resistance potentiometer running from H.T.+ to cathode. Assuming a potential of 250 volts exists between these points, the positive bias of a volt will be obtained at the junction between a 500- and a 125,000-ohm resistance (Fig. 9).

When a gramophone pick-up is to be introduced, a well-insulated two-way switch may be fitted in the grid circuit of the detector, connection to either tuned circuit, or pick-up, while the earthed pick-up lead may be taken to a tapping on the negative biasing resistance. Wire-wound biasing resistances usually possess a safer margin of current-carrying capacity than those consisting of deposited resistance material. The latter type should be rated to dissipate at least 2 watts.

Explanatory Notes on the Circuit Diagrams reproduced on the opposite page.

1. When an anode current I traverses the resistance R a bias $V = IR$ is applied to the grid.
2. Output stage in which the grid bias is produced by the voltage drop across a resistance. If the anode current is 20 mA. and the resistance has a value of 1,000 ohms then a bias of 20 volts will be applied to the grid. Note that the anode voltage is reduced by the amount of grid bias.
3. Biasing an H.F. stage. The cathode is connected to the H.T. – through the resistance R_1 and the voltage drop thus produced is applied to the grid. This resistance (R_1) forms part of the screen voltage potentiometer ($R_2 + R_3$). $V_1 = R_1(I_1 + I_2)$. $V_2 = \frac{R_3 \times \text{max. voltage}}{R_1 + R_2 + R_3}$ approximately. In determining V_2 the comparatively low resistance of R_1 may be neglected although it is carrying both the current of the potentiometer and the valve.
4. Practical circuit developed from Fig. 3 showing suggested values for the resistances.
5. Modified schematic circuit of an indirectly heated screen-grid valve in which the potential of the cathode is the same as the mean potential of the heater.
6. The circuit of Fig. 5 shown in practical form. As the ends of the resistance R_1 are connected to the common leads H.T. – and earth, care must be taken when introducing a second similarly biased stage.
7. In this arrangement the total anode current produces a voltage difference across the resistances R_4, R_5 and various voltages as required may be passed to the several valve stages through suitable decoupling resistances (R_6). In this instance R_4 produces the correct grid bias for the H.F. stages, while R_5 arranged as a potentiometer serves as a volume control by increasing the bias. Other resistances may be placed in parallel with R_4, R_5 to produce other biasing potentials such as may be required by an anode bend detector or when amplifying from a gramophone pick-up.
8. Anode bend detector circuit arranged to avoid difference of potential between heater and cathode. The point X is connected through a decoupling resistance to a point on the resistance R_5 of Fig. 7. Only when a reduction of anode voltage is required will the potentiometer R_7, R_8 be necessary.
9. Leaky grid detector with positive bias. A high resistance potential divider is connected between H.T. + and cathode return lead and a small positive potential applied to the grid through the leak resistance. It should be noted that the low voltage end of the potential divider must not connect direct to the H.T. – when negative biasing resistances are interposed.

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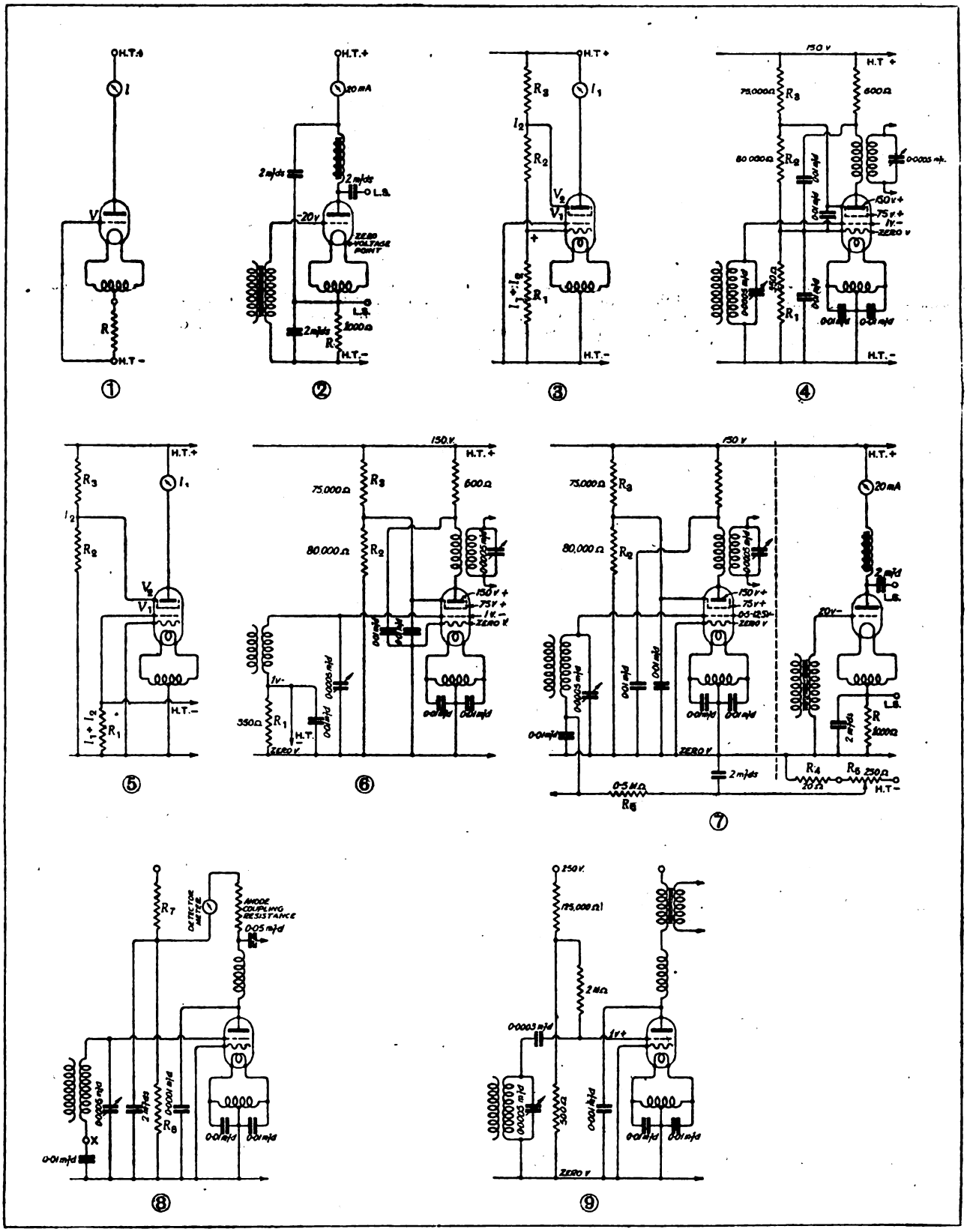

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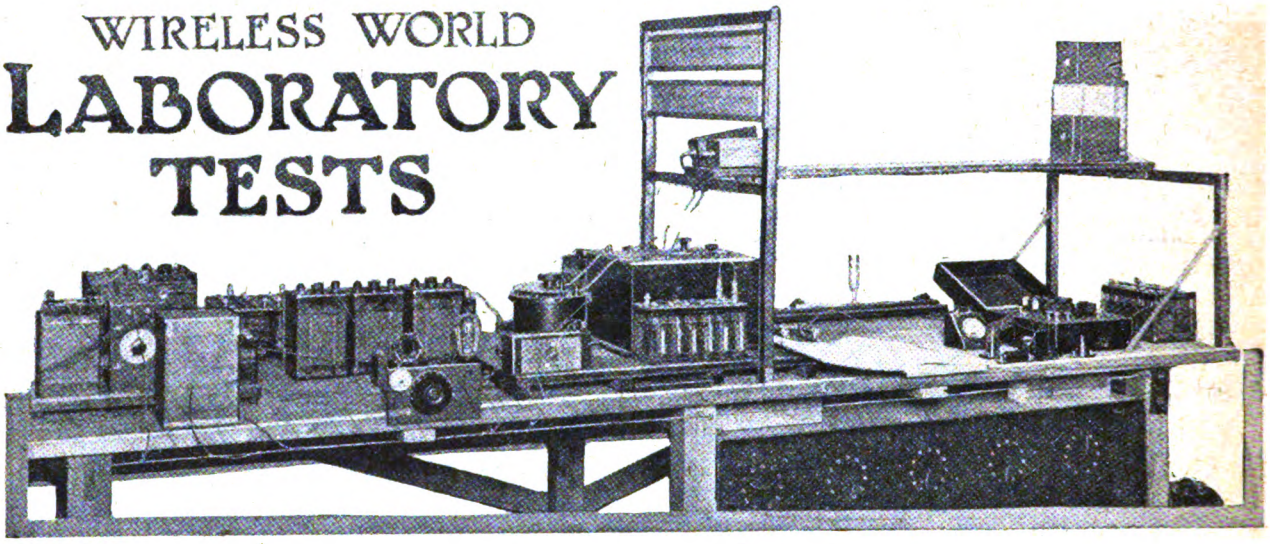
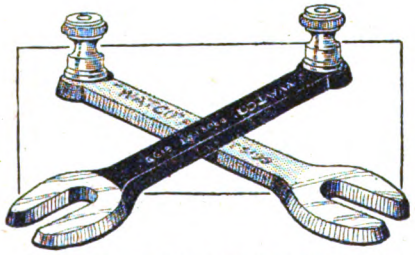
WIRELESS WORLD LABORATORY TESTS



A Review of Manufacturers' Recent Products.

"WATCO" L.T. TERMINAL TAGS.

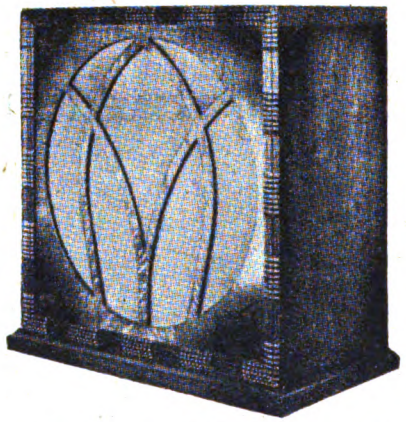
The restriction of space in portable, and transportable sets often necessitates accommodating the L.T. accumulator in a rather inaccessible position, with the result that one's patience is occasionally seriously taxed in making satisfactory connection between the L.T. leads and the cell. The operation of connecting and disconnecting the cell for recharging purposes can be made delightfully easy by fitting the extension lugs supplied by the Waterloo Tool Co., Ltd., 21 and 23, York Road, Lambeth, London, S.E.1. These are made from soft lead coated with non-corrosive paint and provided with a terminal at one end and shaped lugs at the other for gripping under the terminals on the battery. They are supplied in red and black colours as a means of identifying the polarity of the battery. The price has been fixed at 6d. the pair.



"Watco" extension terminal tags for use in portable sets where the L.T. cell is not readily accessible.

AMPLION STANDARD CABINET CONE LOUD SPEAKER.

This new speaker, to be known as Model A.B.6, has been introduced to replace the earlier Models A.C.25 to A.C.29, and is the only balanced armature model loud speaker made by this firm. It occupies an intermediate position between the Amplion Lion and the cheaper "Junior" types. It is housed in a handsome cabinet measuring 14½in. × 14½in. × 8in. deep, with an ornamental front, and is acoustically



Amplion new Standard Cabinet Cone Loud Speaker, Model A.B.6, in polished oak case.

open at the back. Four large-diameter holes provide free egress for the sound-waves emitted from the back of the cone. The confining of these waves often leads to bad cabinet resonance and impairs reproduction.

A feature of special interest is the provision of three input terminals, which gives the choice of three different loud-speaker impedances, and enables that most suited to the particular output valve fitted to be employed. For test purposes the receiver used was fitted with an output valve having an A.C. resistance of 1,600 ohms and an output filter. With this arrangement the medium impedance winding gave the best all-round results. The high impedance winding should be used with valves of between 2,500 and 4,000 ohms A.C. resistance.

A practical test showed that with normal electrical inputs the frequency band to which the instrument gave good audible response was from about 150 cycles up to 4,500 cycles. The speaker favoured the frequencies below 800 cycles, and showed a noticeable cut-off at 150 cycles.

The instrument is sensitive, and will accept quite large inputs before showing signs of distress.

The makers are Messrs. Graham Amplion, Ltd., 26, Savile Row, Regent Street, London, W.1, and the price of the Model A.B.6 in a polished oak cabinet is £4 10s.

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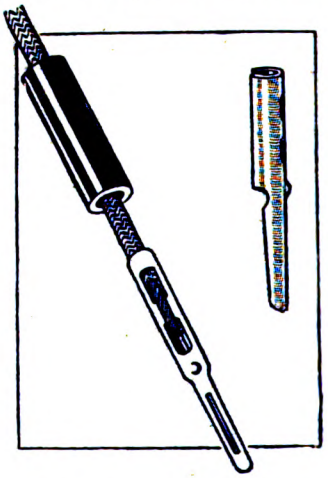
"GOLTONE" SPRING WANDER-PLUG.

Two parts only are used in this wander plug. The prong and wire anchorage are stamped in one piece from hard brass,



"Goltone" spring wander-plug.

and the bared end of the flex is gripped by first threading this through two holes

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and pushing a sleeve of insulated material over the shank.

The prong is "D" shaped and given a slight taper to enable the plug to accommodate itself to different-sized sockets in the H.T. battery. To differentiate between positive and negative leads, sleeves in red and black coloured material are supplied. The makers are Messrs. Ward and Goldstone, Ltd., Frederick Road Pendleton, Manchester, and the price has been fixed at 1½d. each.

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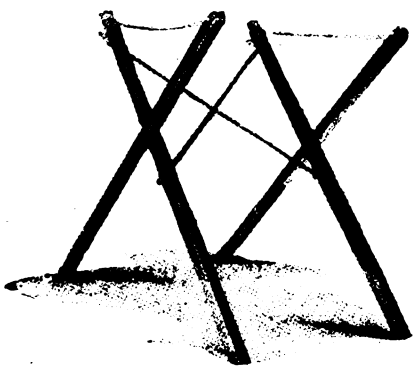
BELLING-LEE "RADIO-LEGS."

A simple but effective device for converting a table type receiver into a pedestal model has been introduced recently by Messrs. Belling-Lee, Ltd., Queensway Works, Ponders End, Middlesex. This consists of a cleverly designed folding leg type table, but without the usual top. Attachment is a very simple matter, and the device is adjustable to accommodate most sizes of cabinets from a small loud speaker to that required to house a five- or six-valve set.



Belling-Lee "Radio-Legs" convert a table model set into a pedestal type and are adjustable to suit any sized cabinet.

The legs are first pulled out to the width of the cabinet and locked by the small nuts provided. Having opened out the cross legs to slightly more than the depth of the set, they are held temporarily in position by a chain at both sides. The set is then placed in the claws on the top of each leg, and two wing nuts tightened until the chains are taut. The set will then be rigidly attached to the legs and can be carried about with ease, at the same time possessing the advantage that it can be placed in any convenient corner.

These legs can be used also to support portable and cabinet type gramophones. They are available in oak or mahogany finish and sell at 15s. 6d. the set.

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RADIO-GRAMOPHONE CABINET.

The Premier Supply Stores, 165, Fleet Street, London, E.C.4, has introduced recently a radio-gramophone cabinet provided with spacious compartments for loud speaker, batteries, receiving apparatus and gramophone equipment. It will accommodate a set measuring 22in. long, 8in. high, and 16in. deep. The overall dimensions of the cabinet are 36in. high, 24in. wide, and 19in. deep. A well is provided to accommodate the gramophone turntable and tone arm. The motor board is made of nine-ply wood.

Handsomely finished radio-gramophone cabinet by The Premier Supply Stores.

The cabinet is handsomely finished in polished oak and the price has been fixed at £4 19s. 6d. An ebonite panel, cut to size, finished and polished in either black or "mahoganite," and measuring 21 x 7in., can be supplied for an additional 3s. 6d.

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"TWIN-CONE" TWENTY.

Linen diaphragms mounted back-to-back, with their apices touching, have been found to give surprisingly good reproduction, the suppleness of the material preventing well-defined diaphragm resonance. Best results are obtained when the two cones are of dissimilar size.

The constructional work involved necessitates access to a well-equipped workshop, but now this need not deter the home constructor, since Messrs. Green and Faulconbridge, Ltd., Coventry, have placed on the market a kit containing all the parts required for the construction of a double-cone linen diaphragm.

The kit consists of 17 packets and contains 149 parts. The main frame is assembled from iron bars, and the sides from stout cardboard finished to resemble grained wood. The finished article measures 20in. square and 8in. deep.

A cabinet is unnecessary, unless particularly desired, since the diaphragm material is not displeasing in appearance and the stout cardboard sides give the impression of a wooden case. Four rubber feet are included to prevent damage (and to absorb vibration) should the loud speaker be rested on a polished cabinet or table.

Provision has been made to enable most of the well-known cone movements to be used. However, the makers offer a special movement for building into the case: this is referred to as the "Twin-Cone" movement, and sells at 15s. The price of the kit is 21s.

A slight modification has been made in recent outfits. Lighter corner-pieces are now included as standard, and, as an alternative to the stout linen for the diaphragm, thinner material can be supplied. This renders the speaker more sensitive and is recommended when small power output valves are used.

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It has been brought to our notice that the price of the Pilot "Resistograd" reviewed in our issue of October 30th last should be 5s. and not 4s. 3d., as stated. The error on the descriptive leaflet was not notified in time to include the correct price.

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In our issue of October 30th last mention was made of the Calton Stewart H.F. choke under "Laboratory Tests." The address of the manufacturers should read 28, St. Enoch Square, Glasgow, and not as stated, the business having been transferred from Edinburgh some time ago.

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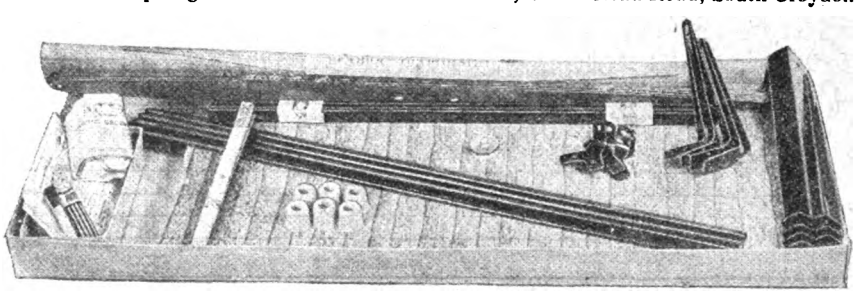
TRADE NOTE.

On November 18th the Carrington Manufacturing Co., Ltd., opened their new showrooms and sales department at 24, Hatton Garden, London, E.C.1. The showrooms are open from 9.30 a.m. to 5.45 p.m. daily, with the exception of Saturdays, when they close at 12.30 p.m. Small stocks are kept for emergency purposes only. Orders should be sent, as hitherto, to the main depot at Camco Works, Sanderstead Road, South Croydon.



Complete set of parts contained in the kit of the linen diaphragm "Twin-Cone Twenty."

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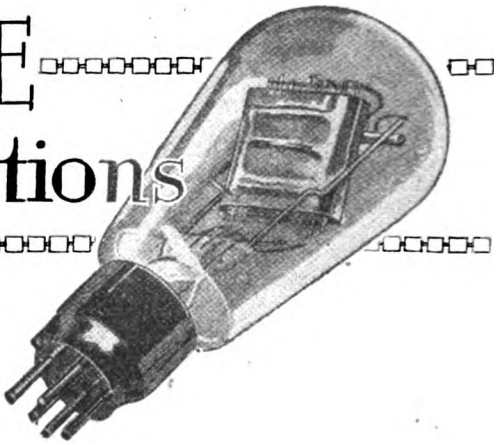
THE PENTODE Under Working Conditions



Calculating the Power Output of Triodes and Pentodes under Correct Load Conditions.

(Contributed by the Research Department of the General Electric Company.)

THE intelligent operation of a loud speaker is dependent upon an understanding of the properties of the output valve. Thought must be given to the correct conditions of load necessary to obtain the maximum undistorted output. Attention is drawn in this article to the excessive voltages developed when using a pentode incorrectly.

IN dealing with three-electrode valves from the point of view of the correct impedance to connect into the anode circuit to obtain the maximum output it is best to use curves in which ordinates are anode current and abscissæ anode volts with curves drawn for constant grid voltages; Fig. 1 shows such a set of curves for an LS5 valve.

Suppose a valve is connected up as in Fig. 2 to a resistance load with an inductance that has a much greater impedance and a condenser that has a much lower impedance than the load resistance.

Suppose now normally the H.T. voltage is 300 and the grid bias is −30. Then with no alternating voltage on the grid the anode current will be 22.5 mA. and the point P on Fig. 3 will represent conditions in the valve as to anode current, anode volts and grid volts (assuming negligible D.C. voltage drop in the choke).

If now an A.C. voltage is applied to the grid, there will be an A.C. component of the anode current—if the anode current increases by $\delta 1$ amps the current through R will be $\delta 1$ amps; the voltage across R will be $R\delta 1$, and hence the anode voltage will drop by an amount $R\delta 1$. Thus, if on Fig. 3 a straight line is drawn through P such that its slope in

$$\frac{\text{volts change}}{\text{current change (amps)}} = R$$

then whatever voltage is applied to the grid the corresponding anode volts-anode current state will be determined by a point lying on this line.

In Fig. 3 XPY is the line through P corresponding to R = 10,000 ohms; this figure is checked, for by considering the points where the line cuts the axes it is seen that an increase of 520 volts causes a decrease of 52 mA.; hence the corresponding resistance is:

$$\frac{520}{0.052} = 10{,}000 \text{ ohms.}$$

Having our 10,000-ohm line through P we can now study what happens when the grid voltage is varied; when the grid has been swung from 10 volts + from its normal biased condition of −30 volts its voltage will be −20 and the anode

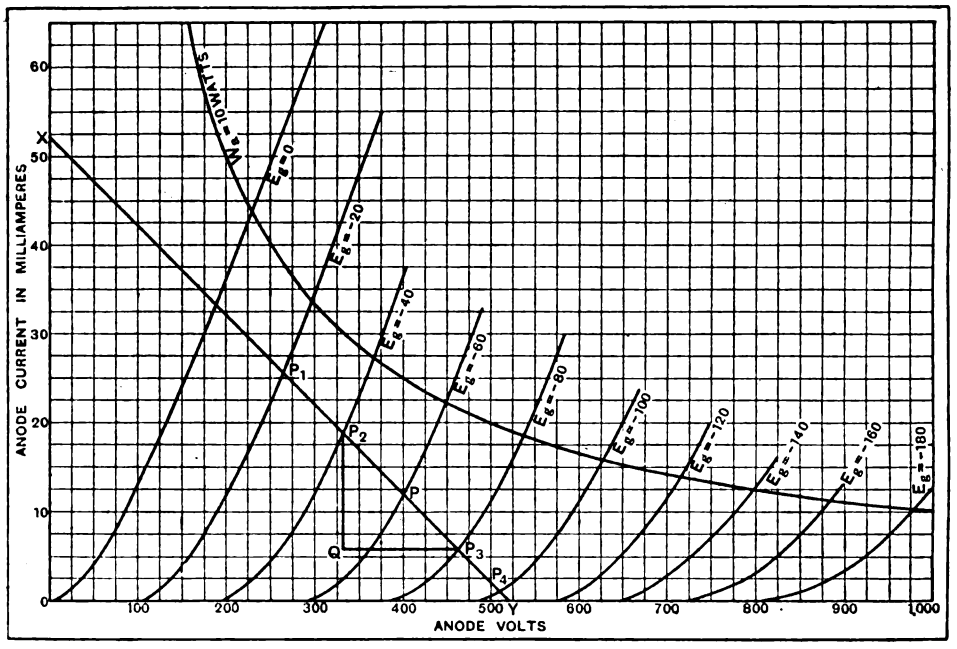


Fig. 1.—Anode current-anode voltage curves for an LS5 valve. The power output triangle P_2 Q P_3 represents only a fraction of the permissible output.

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The Pentode Under Working Conditions.—current and volts will be given by the point where the line XY cuts the −20 volts grid line, i.e., the point marked P_2.

Similarly, when the grid voltage has been increased by 30 volts, the grid voltage will be zero and the point P_1 where XY cuts the Eg=0 line will give the corresponding anode current and voltage.

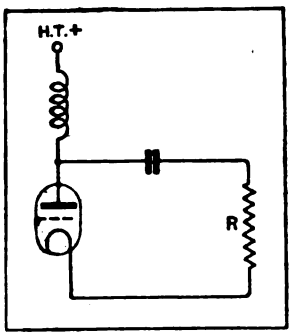

Fig. 2.—Circuit with load R connected to valve output. The inductance has an impedance greater than the load and the condenser impedance is less than the load.

Here we come up to a limitation, for if we swing the grid more positive still we shall have grid current which will cause distortion of the input voltage. Thus the useful portion of the line XY extends upwards from P to P_1; as the voltage applied to the grid will be symmetrical we shall require to swing the grid negative by an equal amount; since we are to swing upward from −30 to 0 we shall have to swing from −30 to −60 volts on the grid arriving at the point P4. Thus with 30 volts bias we can swing the grid from 0 to −60 and our anode current and volts will follow the line P_1P_4. The total change in anode current will be the difference of the currents corresponding to the points P_1 and P_4 and will be 33−12=21 milliamps. This will be twice the peak value of the A.C. component of the anode current so that the R.M.S. A.C. current through R will be $\frac{21}{2\sqrt{2}}=7.5$ mA. approximately. Similarly, the total voltage swing across R is the difference of the voltages corresponding to P_1 and P_4 and is 405−180=225, and here again to get the R.M.S. value we must divide by $2\sqrt{2}$; hence the R.M.S. voltage is $\frac{225}{2\sqrt{2}}=80$ volts approximately. Thus the power delivered to R is $\frac{80\times 7.5}{1000}$ watts=0.6 watt.

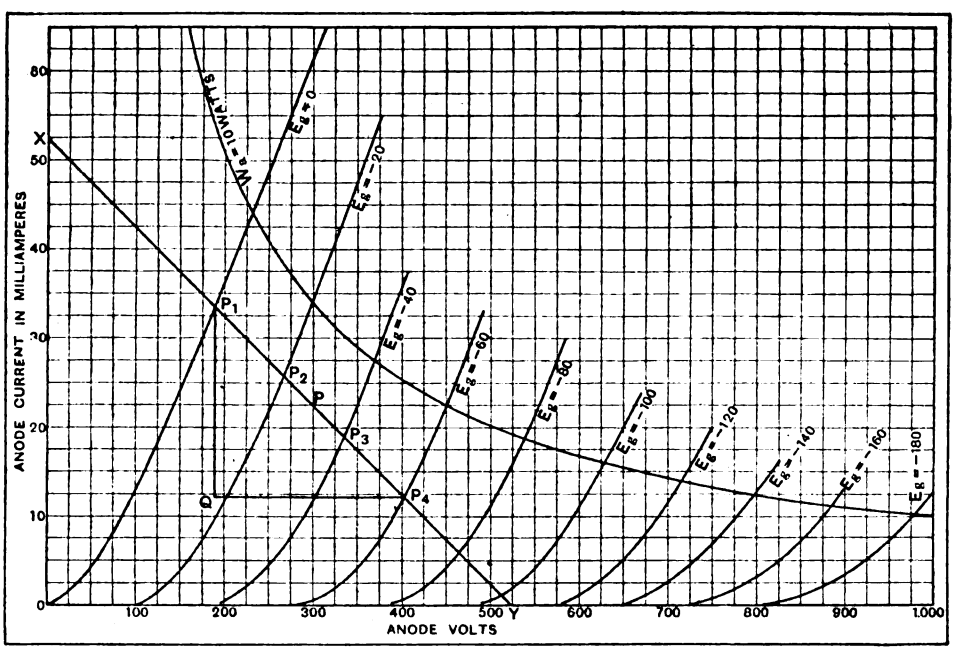

Fig. 3.—Operating conditions for an LS5 valve with 300 volts H.T. and 30 volts bias. Note that the 10 watt dissipation curve is not cut.

We may note that if we draw a right-angled triangle P_1QP_4 the watts are proportional to the area of this triangle, and are in fact equal to one quarter of its area in volt amps. In the present case we note that each volt change on the grid as we pass from P_1 to P_4 along the line P_1P_4 produces equal changes in anode current and voltage, thus the current through R is practically a distortionless replica of the grid volts. This may not be always so, for suppose as in Fig. 1 we had set the anode voltage at 400, the grid bias at −60 and as before take R=10,000 ohms. Then if we proceed as before we might say that we could swing upward from −60 to 0, but it is necessary now to consider the other half of the swing from −60 downwards.

It is seen at once that soon after the grid has swung more than an additional 40 negative volts to point P_4 difficulties arise in that there ceases to be any anode current at all, and further that during the part of the swing −80 to −100 between the points P_3 and P_4 the change in anode current per unit change in grid volts is less than throughout the portion P_1 to P_3 of the curve since the length P_3P_4 is less than P_1P_2, P_2P or PP_3. This will cause distortion and we can say with this setting that we should not swing past P_3. This limits us in the other direction and thus P_2 to P_3 is the extent of the distortionless part of the XY line that we may use.

In practice neither the settings given in Figs. 1 or 3 would be used, but we should by trial and error obtain a line so that the mean bias point P comes in the centre of the usable portion of the line XY, that is the part between the line Eg=0 and the point where distortion occurs due to the curvature of the lower parts of the characteristics.

For example, with a resistance of 10,000 ohms we merely have to draw a number of lines on Fig. 3 parallel to the line XY and pick out the most suitable; this can be done for a number of values of resistance and the maximum watts on each case tabulated; we can then pick out the optimum conditions. When, as is the case with small valves, there is a limitation on the anode

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The Pentode Under Working Conditions.—volts usually the optimum resistance is about twice the internal resistance of the valve. With larger power valves and power modulators where there is a limitation on the standing anode watts loss, the optimum resistance may be much more than twice the valve resistance.

Pentodes.

Pentodes, which we shall now examine, however, give quite different results, for we shall find that the optimum load resistance is much less than the internal resistance of the valve.

Curves of a pentode are shown in Fig. 4 and we can proceed in an exactly similar way to determine the optimum condition.

In Fig. 4 the line XY is the line corresponding to a 60,000-ohm load with 150 volts on anode and screen and −9 volts grid bias.

Suppose we swing the grid voltage from −6 to −12, i.e., 3 volts on either side of the bias, then we note that the lengths intercepted on XY on either side of P are very unequal in swing up to −6 on the grid; the anode volt swings down from 150 to 42, a difference of 108 volts, but in swinging down to −12 volts the anode swings up to the point where the e = −12 volt line cuts the XY line; this is off the diagram, but is about 450 volts, so that the increase in anode volts is 450 − 150 = 300, nearly three times these corresponding decreases when the grid swings to −6.

Since the anode current changes are proportional to the anode voltage changes there is corresponding anode current distortion. A further examination shows that with this loading we ought not to swing the grid more than about 1½ volts above and below −9 volts if we are to avoid serious distortion. If we were to swing the grid from 0 to −18, then the maximum anode voltage would be the point where the Eg = −18 line cuts XY. This is well off the diagram and would be somewhere about 1,100 volts, entailing, of course, great distortion, besides being very dangerous. These high peak voltages can be readily observed by using a peak voltmeter.[1] Let us now draw a 10,000-ohm line as in Fig. 5 with the same initial conditions; we now see that we can swing from 0 to −18 without any very excessive distortion. It is true that the equal changes in grid volts do not cause equal changes in anode current and volts, but the variations are not excessive. Again in Fig. 5 the 5,000-ohm line is drawn, and here again we can swing from 0 to −18 without any very serious distortion.

The triangles giving the full power are drawn and for 10,000 and 5,000 ohms they are about equal areas. If we decrease the load resistance below 5,000 ohms the area of the triangle and consequently the available output decreases. On the other hand, if we increase the

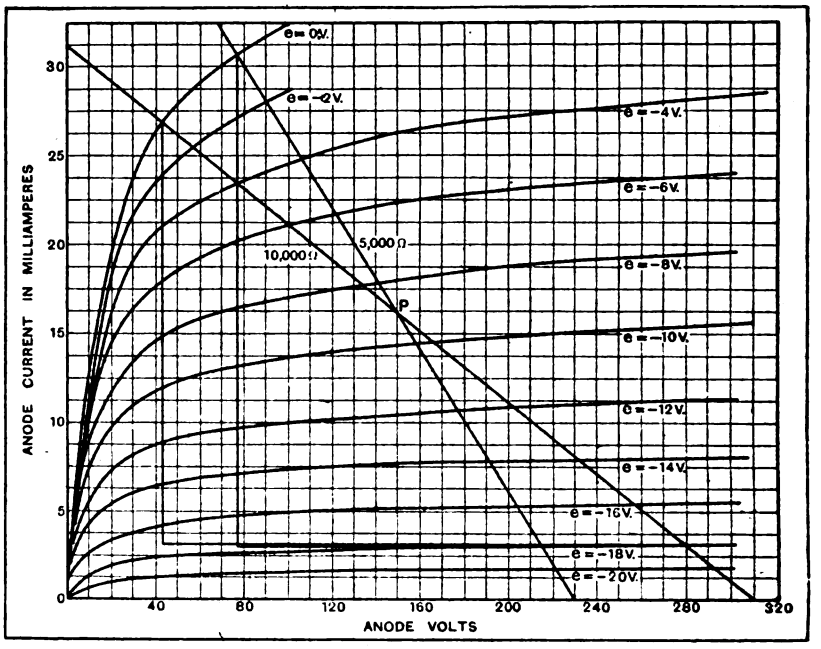

Fig. 5.—Pentode power output triangles for 5,000 and 10,000-ohm loads.

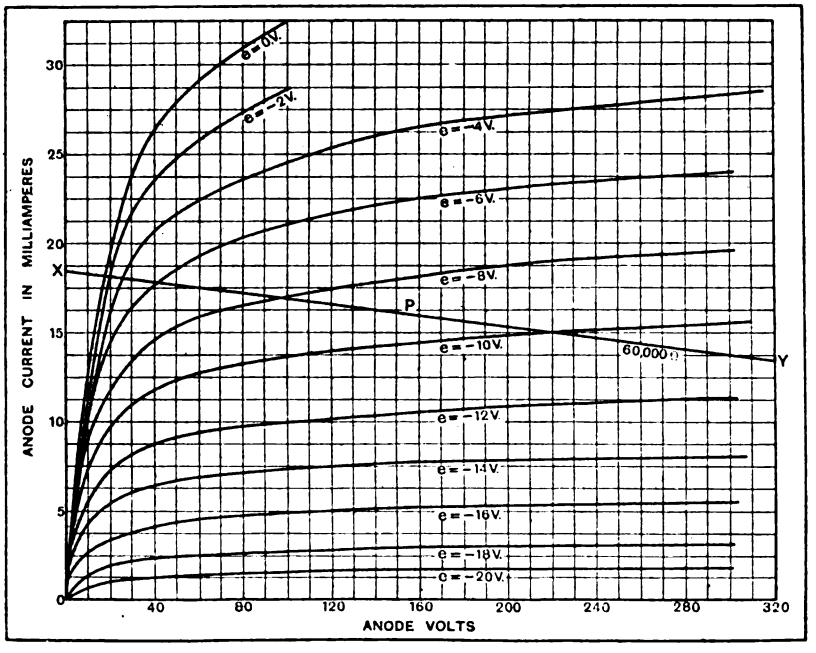

Fig. 4.—If a high resistance load is connected in the anode circuit of a pentode as shown at XY, dangerously high voltages are developed. The line XY would meet the −18 grid voltage line at about 1,100 volts H.T.

[1] *Cf.* Sims, *The Wireless World*, Jan. 16, 1929.

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The Pentode Under Working Conditions.—
load much above 10,000 ohms we have to restrict the grid swing, and again the output goes down. Hence for such a pentode the optimum load is roughly between 5,000 and 10,000 ohms.

We have dealt only with resistance loads, whereas in practice the loud speakers are inductive. The treatment of the inductive load is considerably more complicated, but all that has been said about distortion applies equally well. Many loud speakers of the cone or horn type have impedances of 20,000 to 30,000 ohms or more at frequencies of 5,000 cycles, and if used directly with pentodes will give voltage peaks of 5 to 7 times the H.T. battery voltage. These high peak voltages, apart from the unpleasant distortion, are more than the valve or loud speaker can reasonably be expected to withstand.

A suitable transformer in which the winding having the fewer turns connected to the valve and the winding with the larger number of turns to the loud speaker may be of service.

A transformer connected the other way round will, with most loud speakers, of course, give more " noise " for a very small input voltage; but if the signal is increased unpleasant distortion and dangerous overvoltages will occur.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

B.B.C. TRANSMISSIONS.

Sir,—One of the most sensible and well-reasoned letters ever published in *The Wireless World* was that by Mr. McCormack on October 23rd last regarding B.B.C. transmissions. Any intelligent listener with a wireless set having a performance curve above the level of the first gramophone would agree with him when he says that the only " first-rate " transmissions are the direct or " local " ones, and that the majority of listeners (outside the London area, at any rate) receive as a rule third to tenth-rate transmissions.

It, therefore, causes me agony of soul to read the letter in your issue of November 13th by " Fair Play," of York, Yorks.

Mr. Fair Play's argument is : " Who are you, Sir, to criticise the B.B.C. unless you can first prove that your set and loud speaker are perfect? How dare a mere cutter, bobber, or shingler of side-bands talk of decent reproduction? Who are we —with our trivial bits of amateur apparatus—to stand up in the market place and deride the omnipotent B.B.C.? "

Now this is very quaint. My taste, hearing, sight, and sense of smell and touch are not what they used to be. I have lived, and smoked, and sat up late, and done many things which I should not have done; consequently, my senses are by no means perfect. We all suffer in this way when we have passed the age of callow youth. And yet . . . do I not know a good, succulent, well-done chop when I bite it? Do I not appreciate a well-sung song when I hear it? Do I not love the original water-colour better than the cheap reproduction? Do I not prefer the odour of real lavender water to the synthetic variety which comes from the penny-in-the-slot machine? Do I not respond to the feel of high-class woollies on a cold day? I do. I and my five senses may not be immaculate, but I flatter myself that I can separate the good from the indifferent and bad.

And so it is with my wireless set. It does not boast perfection. It is a thing, no doubt, of weird curves rather than splendid, manly, straight lines. It cuts off side-bands as ruthlessly as I cut off my own side-whiskers every morning of my life. But—in spite of all its terrible, almost-human imperfections—it can always tell me when a long land-line transmission is torturing a work of art. The Manchester Hallé Concerts, as disgorged by 2LO, cut me to the quick far, far more deeply than my set cuts the side-bands. The Bournemouth Orchestra (as relayed from the glass-and-iron concert hall in that delectable spot) makes me sigh for the melody of the first phonograph and the very, very first Edison-Bell record. And when 2LO gives me a poisonous dose of some remote spot like Plymouth, Cardiff, or Pwll-something-or-other, I feel so despondent that, but for my belief in silver linings, I should drink the acid in the accumulators and waft myself to the place where the music *would* be worth while.

An interesting but very harassing experiment which I sometimes try is to gather together the children (whose appreciation of good reproduction is by no means perfect), give them a few minutes with the 2LO uncles and aunts, and then switch over to the Birmingham-*via*-5GB Children's Hour. They invariably ask me why the second lot of aunts talk with plums in their mouths. I reply, sadly, that this is due to " attenuation of the higher frequencies in the land-line " and *not* to side-band amputation. They are good children. They believe me—because they know from experience that Daddy always speaks the truth. Which he does!

It is a poor set which will not show the lack of brilliance, or the harshness, or the undercurrent of extraneous noise, or the surfeit of plums in female mouths, when a long land-line transmission is in full blast. (Eastbourne, for some peculiar reason, excepted!) And it is a very poor set which cannot make manifest the difference between a good transmission and an indifferent one.

Therefore, I say that Mr. McCormack's letter is sound commonsense, and Mr. Fair Play, of York, Yorks, is talking arrant nonsense. Let us not creep too humbly upon the earth's surface, or we shall get from the self-satisfied B.B.C. precisely what we shall deserve—third- to tenth-rate junk.

Twickenham. BERTRAM MUNN.

Sir,—Surely it speaks well for your broadminded attitude to your readers' views that you should print the letter from " Fair Play." What Mr. McCormack said was perfectly correct and not a bit exaggerated. If " Fair Play's " receiver is not capable of distinguishing between the first-rate transmissions from 5GB and 2LO, especially when the programs are from a local source, and the terrible noises that are sent out when a relay from most of the more distant stations is attempted, either it is very poor indeed or his hearing is at fault. Of course there is some side-band attenuation at the receiving end in most cases, but nothing to compare with the horrible attenuation of even the medium high-frequencies that most land-lines give.

Until the advent of 5GB and the new 2LO, listeners in the Midlands were in the position of having receivers considerably in advance of the transmitters—or some of us had. Perhaps " Fair Play " has never heard a good receiver working on a good transmission?

If a gale puts the normal land-lines to Daventry out of commission we are given speech of a quality which, apparently, satisfies " Fair Play," but which we think horrible.

Birmingham. F. G. SACKETT.

Sir,—The impression which the B.B.C. seems to wish to convey about the quality of their transmissions is that they are well-nigh perfect. One is driven to this conclusion : (1) By positive statements to that effect which appear from time to time; (2) by the fact that whilst their official organ contains pages of criticisms, often of a futile kind, about the subject-matter of their

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programs, criticisms of the *quality* of their transmissions are absent; and (3) by the fact that when anybody is rash enough to comment on the transmissions in your valued journal, or elsewhere, somebody else immediately pops up and tells the critic that he should "look to his set."

That our receiving sets are imperfect, more or less, everybody who has the most elementary knowledge of wireless will be ready to admit. That is not, I would submit, really the point at all. The real point is this: When we hear horrid sounds proceeding from our L.S., are we bound to assume that the fault is always at our end My submission is that most certainly we are not, if only for the reason that, though faults at the transmitting end are commonly discounted, nevertheless, in recent times, rather grudging admissions have appeared which urge difficulties associated with land-lines and "transients."

These admissions raise a number of questions, as, for example: What steps are being taken to get over the land-line trouble? What progress, if any, is being made in dealing with transients? And, thirdly, are land-line troubles and transients the only causes of the horrid sounds? As regards the third of these questions, let us take one or two examples:—

(1) The first few bars of a choral item are emitted by my L.S. They suggest that the singers have been dining on coarse fish and that some of the bones have stuck in their throats. Then there is a kind of rumpling sound from the L.S., and 90 per cent. of the fish-bones seem to have been swallowed. Was this rumpling sound due to the swallowing of the fish-bones or the swallowing of transients, or was it, perchance, due to a switch?

(2) A piano recital from the studio begins in such a way as to suggest that the pianist has, with his opening chords, broken 80 per cent. of the strings of the piano. Suddenly the volume is lowered by 300 per cent. and only about 10 per cent. of the strings appear to have been damaged What is it that has brought about this curious change?

(3) I listen to a piano item from Queen's Hall. It is a remarkably good reproduction of "the real thing." The concert ends, the voice of a giant tells me what the weather has been like to-day. I tone down the giant with my volume control. In due course he finishes and is followed by the usual piano item. I observe that, though I am receiving this piano item at only about one-eighth of the volume of the item from Queen's Hall, nevertheless the studio item produces the broken string effect, whereas the Queen's Hall item did not—or only very slightly. How exactly is this explained in terms of land-lines and transients?

(4) The announcer states that Thir Thamuel Thmith ith about to give one of hith thathinating dithcourtheth. Is the announcer speaking across a land-line from his bedroom, as depicted by Mr. Hammond, p. 334 of the B.B.C. Year Book? Or is it that my set is incapable of dealing with such high frequencies as the ss and ff? Well, I am forced to the conclusion that Mr. Hammond's picture of the announcer is not quite so innocent a joke as might appear at first sight. For when Sir Samuel begins, not only do the ss and fs appear clearly but the ss actually whistle!

Now, sir, criticism is of little use if not constructive. So here are some suggestions: (1) That you continue the good work of publishing letters commenting on the quality of the B.B.C. transmission. (2) That you let us have an article or series of articles showing the *kind* of faults which we may reasonably attribute to faulty transmission and not to our sets. (3) That if the B.B.C. are unwilling to undertake the work themselves and tell us about it, some other public body, equipped with all the necessary and expensive instruments—perhaps the National Physical Laboratory—should carry out periodical and exact tests of transmissions under varying conditions and publish the results. (4) That we amateurs should, somehow or other, get together and evolve a scheme whereby we can compare notes about the transmissions and so help each other to decide whether the faults we notice are to be attributed to our end or to the transmitting end. This last suggestion may be difficult to carry out, but surely it is not impossible. Perhaps some of your readers may be able to make helpful suggestions about it? E. C. RICHARDSON.

Sir,—Such touching faith as that expressed by "Fair Play" in his letter published in your issue of November 13th is, in these days, most refreshing.

Most of your readers will, however, not be prepared to accept "Fair Play" as a competent judge, for he does not appear to be situated in such a position as to be able to take advantage of wireless reception under ideal conditions.

Situated as I am, less than two miles from 2ZY, I can, and do, use "high loss" coils which effectively prevent loss of sidebands, together with an amplifier which follows B.B.C. practice closely and which is admitted to amplify fairly evenly all frequencies between 25 cycles and 6,000-7,000 cycles, and I unhesitatingly endorse Mr. McCormack's comments on land-line transmissions.

One has only to hear a transmission from 2ZY of the Northern Wireless Orchestra (playing in the new studio) and to compare it with any land-line transmission from 2LO (of an orchestra, of course) to realise the enormous difference. In the case of the land-line transmission (whether from the London studio or from the Queen's Hall) the bass lacks "body," the drums are extremely poor, and violins are thin and lack the characteristic timbre of a violin.

But, apart from the technical aspect of the matter, why should London listeners benefit at the expense of that great body of provincial listeners, in numbers many times greater than listeners to 2LO?

Why should not the National Orchestra or B.B.C. Symphony Orchestra be formed in Manchester, where the finest body of orchestral musicians in this country resides and where, in addition, there is the finest broadcast studio in Europe?

Manchester. JAS. HUDSON.

CONCERTS FROM RADIO PARIS.

Sir,—It will no doubt be of interest to your readers to know that we have arranged for a series of weekly recitals to be given each Sunday, broadcast from Radio Paris.

These recitals will last an hour and will consist of varied popular music, the concert for Sunday, Dec. 1st, for instance, was dance music played on Decca records by leading Decca dance bands from 2 to 3 p.m.

We believe that we are the first gramophone company to book an exclusive hour for the entertainment of listeners.

THE DECCA RECORD CO., Ltd.

London, S.W.9.

NON-RADIATING SETS.

Sir,—I would like to express my sympathy with Mr. Henry W. Moss.

I have had the same trouble for the last eighteen months and on all wavelengths covered by the "Everyman Four."

It is very seldom I can listen to a programme without interference of one kind or another, either "howling" or "silent-point" oscillation. (I reported the matter to the B.B.C. in June or July, 1928, and the G.P.O. has been dealing with it for over twelve months and can give me no hopes whatever.)

I also know of a road less than a mile from here where one listener switches off and another says he will give up wireless owing to interference.

I certainly think reaction ought to be prohibited, because I feel sure all this trouble is caused by people "playing" with their sets, and the quality of transmissions must be improved if the ether could be cleared of these "heterodyne howls."

London, S.W.8. A. W. SNARE.

Sir,—Mr. Moss, in your issue of November 6th, proposed that legislation should be introduced prohibiting the use of reaction. I assume, of course, that he meant this to apply only to sets intended for reception on broadcasting wavelengths, since it would render amateur communication on short waves more difficult.

Although anyone who lives in a crowded district will heartily agree to it, this idea is too Utopian to be useful. If, as in France, the larger percentage of sets were commercially built, the legislation could be enforced by limiting manufacturers to circuits without reaction. But in England I think home constructors predominate. It would need an enormous (and incidentally expensive) army of men to go to every house having an aerial and examine the set.

There is another consideration. A man who is an inveterate

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fiddler will, if he has no reaction control with which to play, adjust some other part of the receiver. The final result of his unskilled efforts will be further oscillation, and the situation will then be as bad as before. "R.N."

Sir,—I read the letter from Henry W. Moss in your issue of November 6th with great sympathy.

My own set has a neutralised H.F. amplifier, and I am quite satisfied causes no interference. I would, however, willingly conform to such legislation as he suggests, and make the necessary alterations to my set, if such legislation would relieve me of the intolerable interference caused by the howls of my neighbours.

I recently sent a complaint to the B.B.C., and a P.O. official has visited the neighbourhood. Conditions were better for a few days, but are again becoming as bad as before.

Grimsby. "FELLOW SUFFERER."

EMPIRE BROADCASTING.

Sir,—One has always understood that the purpose of the Empire Marketing Board was to stimulate the sale of Empire products, not to provide entertainment for Empire listeners.

May one make another suggestion—that Empire broadcasting be regarded as a matter for the Imperial Government, that the B.B.C. do the actual transmission, and that the money be provided by the Post Office; they keep plenty of it!

G. M. PART.

The following extract from a letter from a reader in Singapore was received by Mr. Gerald Marcuse, President of the Radio Society of Great Britain, and is published as of general interest:—

Though I am not personally known to you, you are well known to me through your transmissions in the past, when I had a two-valve set. Now I am armed with a McMichael six-valve short-wave superhet, and I was extremely gratified this morning when I read your letter in *The Wireless World* of the 11.9.29 just to hand, promising us your excellent transmissions in the near future again.

Having no broadcast stations in this country, I went to the expense of getting the present set purely in the hope of getting 5SW in a satisfactory state, but all to no purpose. Twenty-five metres is in the midst of a nest of Morse stations, and its 15 kW. are simply swamped out. I and my family are sending you our grateful thanks for the trouble you, as an amateur, are going to take for the benefit of us amateurs in the outposts of the Empire, devoid of all help. For my part, at least, I have been continually writing to the local papers in the hope that our lamentations may some day reach the local or home authorities. Will it not be possible for you to get someone in Parliament to put the question at one of the meetings as to this Empire Broadcast? The Dutch in North Indies and the Americans in the Philippines are gaining ground, and the British wireless trade is suffering. The other day I went to buy a potentiometer of 400 ohms. I had to come home with a German-made potentiometer of 600 ohms and fix it in my set! And this was the only kind obtainable at any price.

I have again written to the local Press to-day and mentioned also your promise. I shall send a cutting in a couple of days.

Kindly give us some notice before you start and state wavelength. I rather prefer you to stick to about 20, as there is too much atmospheric interference at 40. Of course, you are the best judge.

SUPERHETS.

Sir,—Your correspondent's article on the Paris Radio Show was very interesting. He gives three reasons why the superhet. is as universal over there as straight sets are here. Can anyone give me three reasons for the apparent unpopularity here?

SUPER HET.

TELEVISION.

Sir,—In reply to the last paragraph of your editorial of the 20th inst., I would say that the Television Society is alive to the desirability of a comprehensive survey being made with the object of establishing the reasons for the present situation, and, further, of clarifying the future prospects of television broadcasting. The Society feels, however, that very little can be done in this respect without the whole-hearted co-operation of the trade and commercial interests concerned, who should be prepared to meet in a round-table conference together with representatives of the B.B.C. and representatives of this Society. The Society would, I think, welcome such a conference as being in the very best interests of that branch of applied science for which we all share an interest.

I can say at once that the number of members of the Society who systematically receive the television broadcasts as at present arranged is very limited, and there are probably not more than ten of our members who do so.

The Television Society, London, W.C.2. W. G. W. MITCHELL, Joint Hon. Secretary.

CATALOGUES RECEIVED.

Hobbies, Ltd., Dereham. Norfolk.—Autumn edition of Fretworkers' Weekly Journal (October 5th, 1929), containing a design for a Pedestal Wireless Cabinet.

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Higgs Motors, Witton, Birmingham.—Stock list of 1-, 2- and 3-phase induction motors for 50-cycle supplies; also D.C. dynamos and motors. There is a wide range of small machines of less than one b.h.p.

o o o o

Mullard Wireless Service Co., Ltd., "Mullard House," Charing Cross Road, London. W.C.2.—Descriptive leaflets of P.M. Filament Transformer and P.M. H.T. Supply Unit for A.C. mains.

o o o o

The D.P. Battery Co., Ltd., Bakewell, Derbyshire.—Illustrated folder of D.P. Kathanode large capacity L.T. accumulators.

o o o o

The Varley Co., Kingsway House, 103, Kingsway, London, W.C.2.—Loose-leaf illustrated catalogue of Varley main sets and wireless components; also 15-page instructional book on the use and application of this firm's products.

Messrs. C. A. Vandervell and Co., Ltd., Acton, London, W.3.—Illustrated catalogue of C.A.V. high- and low-tension accumulators for wireless uses; also folder dealing with non-spillable cells for portable sets.

o o o o

Messrs. Wingrove and Rogers, Ltd., Arundel Chambers, 188-9, Strand, London, W.C.2.—Illustrated leaflet of "Polar" differential reaction condenser.

o o o o

Messrs. J. H. Taylor and Co., Macaulay Street, Huddersfield.—Illustrated price list of proprietary wireless components stocked by this firm.

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Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1.—Descriptive folder of the "Magnum" short-wave converter. This is used in conjunction with the L.F. portion of the broadcast set, and includes short-wave detector and reaction circuit.

Marconi Wireless Telegraph Co., Ltd., Marconi House, Strand, W.C.2. Leaflets Nos. 1082/2, 1101, 1097 and 1103, illustrating and describing their 100-watt and 500-watt fixed wavelength telephone sets XMB1a and XMC2; the 500-watt telegraph transmitter types MC3a and MC8b, and the 1.5 kW. telegraph transmitter MC13.

o o o o

A. J. Dew and Co., 32-34, Rathbone Place, Oxford Street, London, W.1.—General wireless catalogue of proprietary receivers, components and accessories stocked for the season 1929-1930.

o o o o

Oldham and Sons, Ltd., Denton, Manchester.—32-page handbook entitled "Radio Power Problems," dealing with "Oldham" H.T. and L.T. accumulators and trickle chargers.

o o o o

L. McMichael, Ltd., Wexham Road, Slough, Bucks.—Illustrated and descriptive folders dealing with the "Super-Screened Portable Four," "Screened Dimic Three," and mains-operated receivers. Also full constructional details for the "Home Constructors' Screened Three" receiver.

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BROADCAST BREVITIES

By Our Special Correspondent.

Progress at Portland Place.—Broadcasting in Parliament.—Christmas Programmes.

Broadcasting House.

The Portland Place site is now ready for the massive building designed by Col. Val Myer to house the B.B.C. headquarters. Tenders have now been invited for the constructional work and should be in the hands of the owning syndicate within the next week.

Building operations will occupy more than a year, and it is doubtful whether the opening ceremony can take place much before April or May, 1931.

o o o o

P.M.G. and Brookmans Park.

Seldom does the House of Commons spend so much time on wireless matters as it did on Tuesday of last week—Westminster's wireless day. Besides dubbing himself "the policeman of the ether," the Postmaster-General (Mr. Lees-Smith) had several interesting things to say regarding the activities of the B.B.C., and he made a new disclosure concerning future policy at Brookmans Park. The twin transmitter, which begins tests in a few weeks' time, will commence on low power, gradually increasing its output as the public habituate themselves to the new development. I understand that the first tests will probably not employ more than 5 kW.

o o o o

A Ticklish Question.

If the Postmaster-General's proviso is to be strictly observed, I imagine that the power increase of the twin transmitter will be exceedingly slow. Who is to say when the public have habituated themselves to a broadcasting system which calls for uncommonly selective sets and the virtual abolition of the crystal?

o o o o

B.B.C. to Borrow Money.

Another disclosure, which was not unexpected by those who have studied the B.B.C.'s present financial position, was contained in the Postmaster-General's remarks concerning the development of the regional scheme. Up to the present the Corporation has financed its stations from its reserves, but it is now anticipated that as the scheme develops it may be necessary for the B.B.C. to utilise its power to raise a loan.

The only alternative is to let the scheme hang fire until sufficient funds have accumulated from licence revenue, by which time the B.B.C. might have learnt too much about twin wave transmission!

Savoy Hill and the Pirates.

With a scarcity of funds looming ahead it is not surprising that Savoy Hill regards the "pirate" question with pathetic interest. Questions in the House evoked the P.M.G.'s statement that licence evasions were being gradually reduced, but Savoy Hill remains sad-eyed, the opinion there being that after seven years of broadcasting there should now be 4,000,000 set owners. Licencees number barely 3,000,000.

o o o o

Modulation of B.B.C. Transmitters.

A correspondent in last week's issue of *The Wireless World* pleaded for an equal degree of modulation from all B.B.C. transmitters. An official at Savoy Hill solemnly informs me that uniformity in this direction is always sought by the B.B.C. engineers, and that the degree of modulation never exceeds the boundaries of 2 and 30 per cent.

o o o o

A Disappearing Landmark.

The first and second 2LOs are both being dismantled. The Marconi House plant is already in the last stages of dissolution and will not be long survived by the installation in Oxford Street, which will also lose its masts by the end of this month.

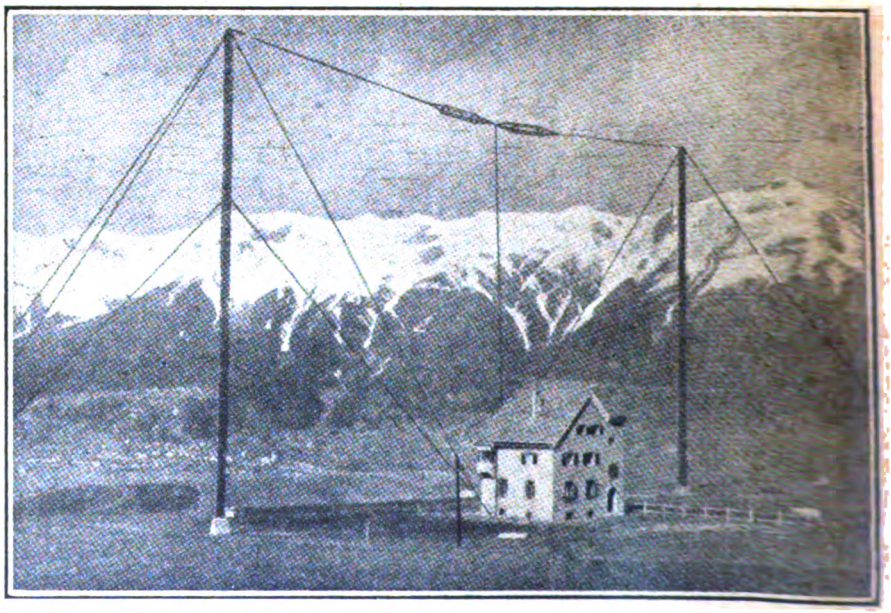
Thus Brookmans Park will have no standby.

o o o o

A Broadcast Christmas.

Seven Christmas seasons have been enriched with broadcasting, and now that we are approaching the eighth it needs an effort of memory to recall those prehistoric festivals when we had to make our own music or listen to the waits.

The Christmas element in the transmissions will begin on December 23rd with the broadcasting of the Nativity Play from St. Hilary's Church, Marazion, Cornwall. Two carol programmes will be given on Christmas Eve, while on Christmas morning 2LO and nearly all stations will broadcast the service from York Minster. Miscellaneous Christmas fare will make up the rest of the day's programme. In the afternoon Bransby Williams will give his well-known impression of Scrooge.



BROADCASTING IN THE AUSTRIAN TYROL.—The relay station at Innsbruck which distributes the Vienna programmes to mountain dwellers. The station is without a regular wavelength but is working provisionally on 287.4 metres.

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READERS' PROBLEMS ANSWERED

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

"The Wireless World" Supplies a Free Service of Technical Information.

Designing Tuning Coils.

Have you ever published information for designing inductance coils to specific H.F. resistance values? Inspired by a recent article, I am thinking of trying filter circuits: hence my question. E. B.

Simple graphs for the design of coils of different H.F. resistances were given in our issue of January 11th, 1928. The range dealt with should be sufficient for your purpose.

o o o o

"Push-Button Regional Receiver."

With reference to your reply to "T F. S." under the above heading in your issue of November 13th, I should like to know if it is possible to simplify the arrangement shown by using a tapping on each of the coils, instead of an extra semi-variable condenser for each tuned circuit. T. C. W.

It might be possible to obtain satisfactory results from a simple arrangement of this kind, but it would be found that the operation of tuning by varying a tapping point on an inductance coil would be a very inconvenient procedure; indeed, it would be almost impossible in a set which, by the very nature of the work it is intended for, must have reasonably selective circuits.

Provision for continuous adjustment of inductance over a limited range can be made by winding a few turns of the coil on a rotatable former (variometer fashion), but this would be no simpler and probably no cheaper than a second semi-variable condenser.

o o o o

"Pentode Two" Conversion.

My "Pentode Two" receiver gave entirely satisfactory results up to the time when Brookmans Park started operations; now I find that interference is so bad that it is a difficult matter to receive any station except 5GB and one or two other transmissions in the neighbourhood of 500 metres on the normal broadcast band. It is found that spreading of signals can be minimised by fitting a smaller series aerial condenser, but reduction to a value that is really effective renders the set extremely insensitive. Can you suggest a method of altering the receiver? I should not object to rebuilding it in a larger cabinet, but do not care to go to the expense of "scrapping" a number of existing parts, and perhaps adding an H.F. stage. R. F. B.

We suggest that you should rebuild your receiver to the general circuit arrangement of the "Two-Circuit-Two" receiver, described in our issue of February 6th.

The two sets are not widely dissimilar, and you will find that all your present parts can be used, and that little additional apparatus will be required.

o o o o

Testing a Variable Condenser.

I have reason to suspect an intermittent short-circuit between the vanes of one of my variable condensers, and, in order to make a test, connected a flash-lamp battery and dry cell across the terminals. The lamp glowed at, apparently, full brilliancy, irrespective of the position of the moving plates. Does this suggest that there is a short-circuit across the frame of the condenser, as the glow was observed when the moving plates were obviously clear of the stator vanes? H. C. F.

It may be that there is, as you say, a complete short-circuit in the frame of the condenser, but this would entirely prevent the reception of signals, and we are more inclined to think that you have forgotten the fact that, in a normal receiver, the variable condenser is bridged by a tuning coil with windings of low ohmic resistance, and, consequently, your test lamp will glow whether the plates are making contact with each other or not.

Before making a test of this sort the tuning coil should be disconnected.

o o o o

The "Foreign Listeners' Four."

When an indirectly heated valve is used as a grid detector, with an applied H.T. voltage not exceeding some 60 or 70 volts, I understand that there is no need to provide any positive bias for its grid. It is proposed to take advantage of this in introducing a slight modification to the "Foreign Listeners' Four"; consequently the grid leak will be connected directly to the valve cathode. With this arrangement it would seem that a very simple addition should make the set suitable for gramophone reproduction; will you please give me a circuit diagram showing how the necessary additions may be made, bearing in mind that I wish to get "free" grid bias if possible. W. G. L.

Your proposed scheme is quite sound, and, indeed, there is a good deal in its favour. We suggest the simple method of connection shown in Fig. 1. This necessitates the addition of a biasing resistance in the cathode lead, and also of a grid circuit switch to make the appropriate changes for gramophone or radio reproduction: as usual, it is desirable that this switch should have very good insulation and low self-capacity.

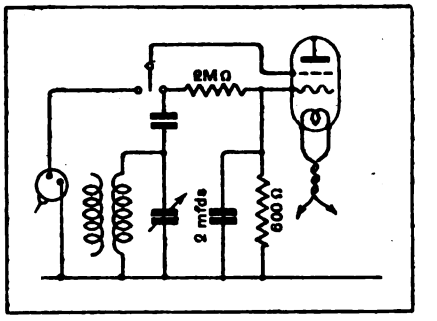

Fig. 1.—Connections of a gramophone pick-up in the detector grid circuit of the "Foreign Listeners' Four."

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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Isolating the Aerial Circuit.

I am about to add a tuned aerial circuit to my receiver and to provide an H.T. feed from my D.C. mains (220 volts with positive earth). Some time ago it was stated in "The Wireless World" that the aerial circuit should, in these conditions, be isolated from the mains, and it has been suggested that a double-wound aerial transformer, with no metallic connection between primary and secondary, is of advantage: is it possible to bring about this isolation when using a two-circuit aerial tuner with capacity coupling? I have studied several circuit diagrams of this arrangement, but it seems to me that they all provide a direct path to earth for the mains. C. R.

So far as isolation of the mains from the normal wireless "earth" is concerned, the capacity-coupled two-circuit aerial tuner does not confer any advantage over any other arrangement, and, if used in the ordinary way, it is necessary to fit the conventional "earth" condenser; to be on the safe side, a second condenser should be inserted in the aerial lead. The need for this can be entirely overcome by fitting a small mica condenser (of about 0.001 mfd.) between the earthed end of the aerial coil and the earth terminal of the set in the manner shown in Fig. 2, where the extra condenser is marked "C."

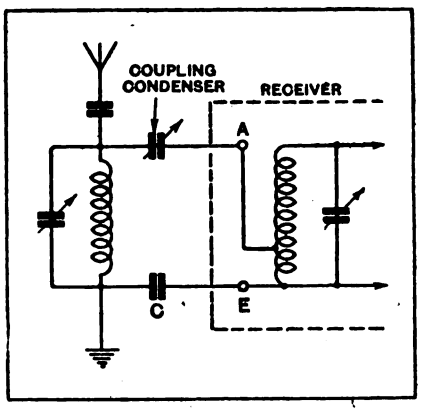

Fig. 2.—A safety precaution for D.C. mains users: a capacity-coupled tuned aerial circuit may be isolated from the supply leads by fitting an extra condenser.

It may be added that this arrangement confers little benefit as compared with the more conventional method, but it does prevent the aerial coil and condenser from becoming "live"—a matter of some importance when these components are mounted outside the receiver cabinet.

o o o o

The Best Variable Condenser Capacity.

I am going to buy three high-grade variable condensers, with the idea of using them for experiments connected with H.F. amplification. What value of capacity do you consider to be the most generally useful? C. C. P.

It is rather difficult to dogmatise on this matter, but, on the whole, we think you would be well advised to choose a value slightly over 0.0003 mfd.—say, 0.00035 mfd. This value is highly suitable for use in modern circuits, as it enables one to cover the normal broadcast waveband very satisfactorily, without depending too much on the lower end of the condenser scale.

By choosing condensers of 0.0005 mfd. you would be safe enough, as they would be suitable for use with coils of any reasonable inductance, but scale readings would be unnecessarily close together with the more popular arrangements.

o o o o

Mistaken Economy.

It is proposed to use a Mazda 2-volt S.G. valve in the H.F. position in my receiver, with 6-volt valves for detection and L.F. amplification. Instead of inserting a resistance in series with the filament of the H.F. valve, in order to absorb surplus voltage, would it not be more economical to feed it through an extra lead from the positive terminal of the first cell (counting from the negative end) of my 6-volt L.T. battery? S. M. E.

We are sure that it would be a mistake to adopt this plan, as the need for recharging your L.T. battery will be determined by the condition of the cell from which most energy is taken. In your case this will be the first one, from which, with your proposed method of connection, more current will be drawn than from the others. Unless special precautions are taken in recharging, individual cells are likely to be either over-charged or under-charged.

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A Simple Bias Rule.

Is it to be assumed that the correct value of negative grid bias of an amplifying valve is dependent upon impedance, and that an increase in impedance automatically implies a reduction in negative grid bias, all other conditions being unchanged? P. R. R.

Generally speaking, this is a safe rule to follow, both with regard to amplifying valves and anode bend detectors. It should not be applied too hastily when dealing with H.F. amplifiers, which are seldom required to accept any very considerable input voltage. It is usual to take advantage of the improved characteristics resulting from the application of the smallest bias necessary to prevent the flow of grid current.

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A Point of Difference.

There seems to me to be very little difference between filter circuits and loosely coupled separately tuned aerial circuits of the type with which we are all familiar. Possibly, however, there is some difference between the two that I have overlooked; will you please give me a few words of explanation? T. W. M.

Basically there is no real difference, but the term "filter circuit" is conveniently applied to an arrangement of two coupled circuits in which a deliberate attempt is made to avoid loss of high notes (or side-band cutting) by so arranging the coupling between them so that something approaching a "double-humped" resonance curve is produced.

o o o o

An Apparent Inconsistency.

After reading a recent article on the subject of H.F. transformer design, I was interested enough to compare the optimum ratios between primary and secondary windings given there with those used in recent receivers described in your journal. I was rather surprised to find that in hardly a single instance are the primaries of these sets as large as theoretical considerations would indicate that they might be; this would suggest that it is considered desirable to sacrifice a certain amount of amplification, but possibly there is some other explanation? C. S. G.

This is another case of compromise, and a good deal depends on the designer's views, although careful consideration will show you that there is something approaching unanimity on this question. The problem of selectivity is at the root of the matter; generally speaking, it is considered best to sacrifice a certain amount of amplification in order to improve the performance of the receiver with regard to the elimination of interference.

In some cases screening enters into the question, and, where complete isolation of the circuits cannot be easily and economically arranged, it is sometimes necessary to forgo amplification to attain complete stability.

FOREIGN BROADCAST GUIDE.

MOSCOW KOMINTERN

(Russia).

Geographical position: 55°42′ N. 37°39′ E.

Approximate air line from London: 1,552 miles

Wavelength: 1,481 m. Frequency: 202.5 kc. Power: 40 kW.

Time: Eastern European (2 hours in advance of G.M.T.).

Standard Daily Transmissions.

G.M.T. 4 a.m. and 5.15 a.m. physical exercises followed by gramophone records; 14.10 gramophone records; 16.15 music lesson; 18.00 main evening concert; 20.00 dance music (Sundays only); 21.55 relay of noises from the Red Square followed at 22.00 by time signal and midnight chimes (to the melody of the *Internationale*) relayed from the Spassky Tower, Kremlin.

Male announcer. Call: *Sloeschaitje! Sloeschaitje! sdie goworit Moskwa.*

Interval call: Radio Moskwa.

On most evenings after 22.00 G.M.T. news bulletins are broadcast; they are read slowly and repeated, in order to allow of transcription.

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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A RADIO CHRISTMAS.

ONCE again Christmas is approaching, and with it, naturally, come thoughts of entertainment round the fireside. To-day winter evenings round the fireside can scarcely be regarded as up to date unless wireless is present to complete the picture. In the matter of giving presents, wireless offers great attractions by reason of the fact that there is so much that is new from which a choice can be made, whilst the variety of apparatus and sets makes it possible to make a selection to suit every pocket.

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OURSELVES.

WE feel that it would be ungrateful on our part if we neglected to express our very keen appreciation of the way in which our readers have reacted to our decision to increase the price of *The Wireless World* from 3d. to 4d., following the announcement which appeared in our issue of November 27th. We had no reason to expect communications approving of our policy, so that to have received quite a large post conveying expressions of opinion from readers which amount almost to congratulations on our decision is extremely gratifying.

We think it would be of interest to quote from a representative few of the letters which we have received. "I do not think any reasonable person would grumble at the increased price of your journal. Some people have wondered how such a well-produced technical weekly could have been published at 3d.—R. B. Smith, Tyr Pwll, Abergavenny." "Don't, for goodness sake, drop the quality of *The Wireless World*, even at the cost of 6d. It is the only paper worth while in the opinion of really interested people.—R. T. Ashton, Hanley, Staffs." "Regarding the increased price of *The Wireless World*, I believe the great bulk of your subscribers will willingly pay the small addition . . . I feel sure you are taking the right course . . . Those whose sole criterion is cheapness, will always be able to indulge it.—A. F., Southampton." "I have often wondered how much longer we were to have our favourite journal for 3d. Here is one only too pleased to pay 4d. or more if required. More power to your elbow.—L. H. Pepler, Ipswich." "I observe that the price of *The Wireless World* is to be increased to 4d. May I say that if it were treble the amount it would still be the best available value for money? *The Wireless World* caters for a large section of the wireless community for whom other periodicals are valueless.—C. J. Carter, Chalfont St. Giles."

One must find an exception to prove the rule, and up to the time of writing we have received only one letter condemning us for our action. This comes from Mr. E. H. Brown, of South Norwood, who disagrees with our statement as to the time and care required before we are able to give publication to the design of a modern receiver. Our critic states, "If you had, say, a fortnight's work in the experimental workshop with the manufacturers' co-operation, plus the services of a draughtsman to make a drawing of it, it would sound feasible." We are told that in regard to our technical information service we should pass over the bulk of our queries "to component manufacturers, who are only too pleased to give technical information, as I have often proved." This communication concludes with the assurance that "further editions at 4d. per copy can remain on the bookstall so far as I am concerned." We must express regret at the loss of a reader, but we feel, at the same time, that Mr. Brown could never have been warmly attached to a paper of which he appears to have so poor an opinion.

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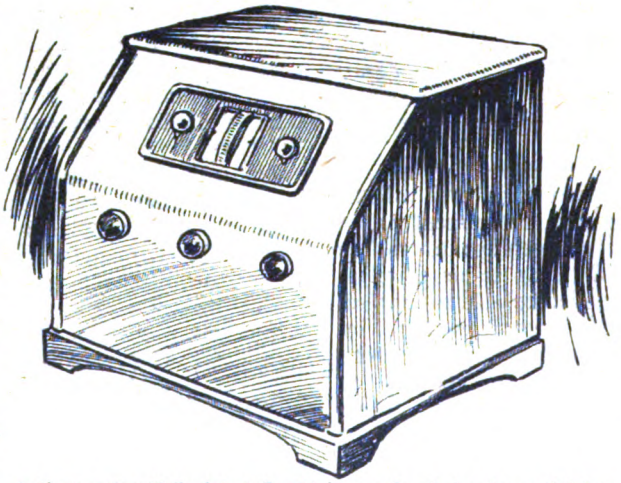
On Choosing a Set

How Decisions are Affected by Changing Conditions.

BROADCASTING technique in this country is passing through a period of transition, and it behoves everyone who is faced with the task of deciding upon the desirable features of a new set, no matter if it is to be bought ready-made or assembled at home, to keep an eye on probable developments of the near future. Naturally, this applies equally to those who, at this season of the year, are giving wireless apparatus as presents, or who are acting in the capacity of adviser to those who are less well informed on the subject.

It is hardly necessary to remind the reader that if present plans come to maturity the whole country will be served, within a couple of years or so, by alternative programmes radiated from powerful twin stations in London (Brookmans Park), at Daventry, on the Lancashire-Yorkshire border, in Scotland, and on the Bristol Channel. These stations are expected to provide signals strong enough to be practically immune from fading difficulties or any ordinary form of interference within a radius of up to 80 miles, and considerably more in the case of 5XX, whose long wavelength is subject to less attenuation.



A three-valve H.F.-det.-L.F. set is a safe choice for satisfying average requirements, as it combines reasonable selectivity and sensitivity with enough volume for ordinary needs.

Choice of a suitable set for given requirements is much more a matter of geography than is generally appreciated—at short ranges, a few miles more or less in distance from the local station makes a world of difference in the "spreading" of its signals—and it might seem at first sight that this opportunity might profitably be used to discuss the best circuit arrangement for operation in various areas. Unfortunately, such a course is impossible, for the very good reason that there is still nothing approaching unanimity as to what is best even for the least complex set of conditions imaginable. The writer cannot hope to do more than deal with general considerations that should be taken into account, avoiding as far as possible a superfluity of "ifs" and "buts" that are apt to be so wearisome when one attempts briefly to discuss a number of points.

Before attempting to make a choice it is wise to devote some thought to forming a fairly clear idea of what is required of the apparatus. Many of us, influenced perhaps in the early days of broadcasting by ill-informed and ill-advised pronouncements as to what a wireless set should do, have set an unduly high standard; it is more than ever difficult to combine superlative quality reproduction with long range in one simple piece of apparatus, and

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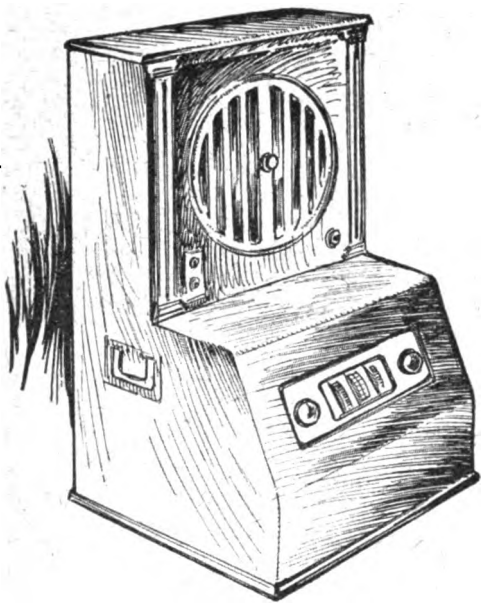
On Choosing a Set.—

there may be a tendency for the popular general-purpose set—jack of all trades and master of none—to give way to more highly specialised circuit combinations.

Be this as it may, it seems likely that a new type of listener will arise, asking for nothing more than the alternative programmes from his local station. Except when he lives on the borderland between the service areas of two regional stations his requirements are easily satisfied. Much has been written on the need



The table portable set—completely self-contained, with built-in loud speaker and frame aerial—is one of this season's innovations, and is proving increasingly popular. Mains-fed models are available.

for selectivity that will manifest itself when the twin stations come into being, but it is always tacitly assumed that other transmissions will be required; if they are not, the problem resolves itself into one of reducing input from the aerial.

Imagine a listener living at a distance of a mile from Brookmans Park; a comparatively crude 2-valve receiver will provide volume only limited by the capabilities of the type of output valve customarily fitted without allowing any mutual interference between the transmissions. All the user has to do is to try various short lengths of aerial until a sufficient, but not excessive, input to the detector is obtained. Of course, similar results may be attained by the use of a fixed aerial and a suitable input volume control.

Disproportionate Cost of an Extra Programme.

Briefly, the position may be summed up by saying that a set with sufficient selectivity to separate the two stations at its maximum range is bound to be capable of separating them at any distance, however short, provided that aerial input can be reduced to simulate conditions existing at a distant point. This proviso implies that the direct pick-up of coils and wiring is negligibly small, or at any rate can be made so by screening.

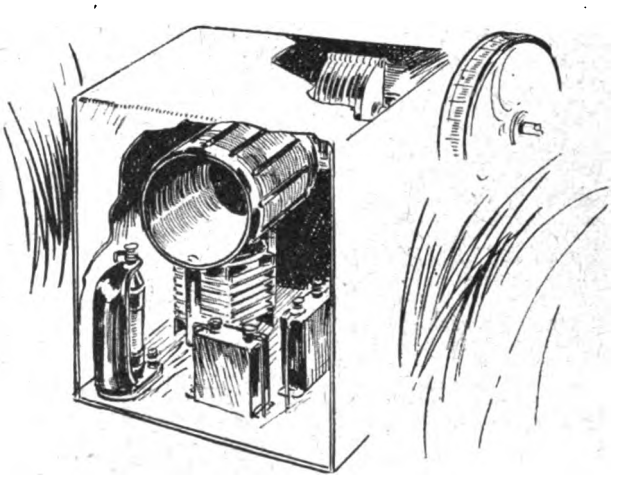
But let our hypothetical listener try for signals from Daventry 5GB, some 60 or 70 miles away—at first sight a modest enough addition to the repertoire of his set. This station may be within its range, but, to obtain sufficient sensitivity, he must increase the dimensions of his aerial—or its coupling, which comes to very much the same thing if a large aerial is normally used—to such an extent that serious interference from the local station will almost certainly make itself felt. This interference can be eliminated only by adding a complicated system of extra tuned circuits, in conjunction with at least one H.F. amplifying valve, and our ideal of a simple and inexpensive receiver is at once shattered in order that a trifling gain may be achieved.

Admittedly this is an extreme case, but it goes to prove that, under anticipated conditions, the reception of anything beyond the local twin transmissions will often be accomplished by considerably increased expense and complexity. In circumstances anything like those envisaged the possibilities of the purely two-station receiver should not be ignored, even if it is used only as an auxiliary to a long-distance outfit which may, of necessity, be rather too elaborate for everyday use.

Laments from Potters Bar.

Influenced no doubt by the minority who loudly voice their complaints regarding interference and the Regional Scheme, one is apt to place undue emphasis on the trials and tribulations of those living in the wipe-out areas surrounding the new stations—existing or projected. No one will grudge them their share of the limelight, and it is only right that their peculiar difficulties should have attention focused on them, although actually they will always be in a minority, and most wireless users will find that the better sets of present design are amply selective. Before attempting to discuss any particular circuit arrangement it is as well to consider one or two general principles about which there has recently been some revision of ideas.

There are still those who profess a distrust of mains-operated receivers, and until quite lately one is bound to admit that there was some justification for their attitude. But now, thanks to a fuller appreciation of



The single highly efficient H.F. stage, with complete metallic screening, scores largely on the grounds of low upkeep cost.

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On Choosing a Set.—

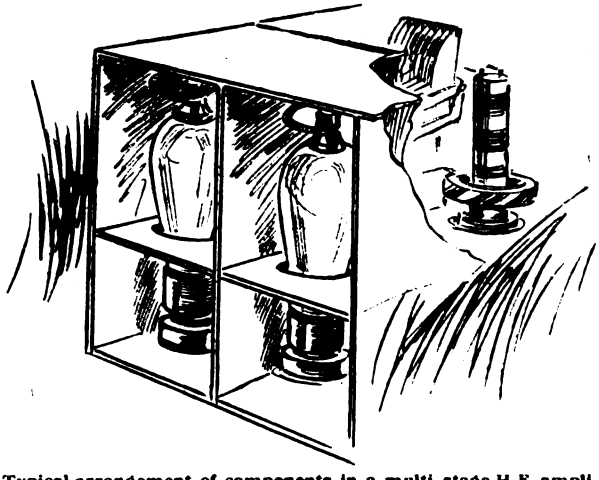
the principles underlying power rectification, smoothing, and, most important of all, the " decoupling " of individual circuits, the general performance and reliability of " mains " sets leaves little to be desired; indeed, it is now considered that battery users are almost precluded, by financial and practical limitations, from obtaining the realistic volume that is so readily available to those with access to a mains supply.

The above applies more particularly to alternating current circuits; although very satisfactory D.C. sets have been produced, it is by no means unusual to depend on the mains for H.T. current, and perhaps for grid bias as well, using an accumulator for filament supply. Incidentally, two-volt valves are now so extraordinarily good, as compared with those of a year or two ago, that there is a noticeable tendency to use them even in the case of quite ambitious sets where 6-volt filaments would previously have been chosen. The upkeep of a " D.C." set with no other battery than a single large L.T. cell is a very simple matter.

Some Eliminator Considerations.

The days when a receiver and an eliminator intended to work together were bought separately and more or less at random are almost over; indeed, the tendency of to-day is to combine the two. If the eliminator is not specifically designed to work with the set concerned, the prospective purchaser should assure himself that the necessary interconnections to the various anode circuits can be readily made.

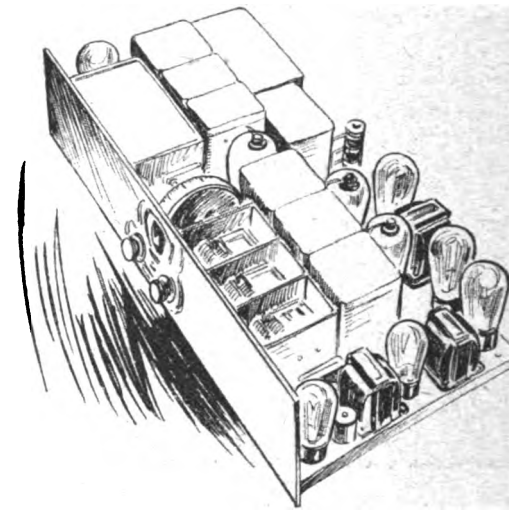
In the matter of price the mains-fed receiver scores



Typical arrangement of components in a multi-stage H.F. amplifier, as included in the most ambitious receivers. Separate screening for the valves is usually provided.

heavily when maintenance expenditure is considered, although its initial cost is apparently disproportionately high until all the factors concerned are properly considered.

This is not the place to discuss the relative merits of " portable " and fixed receivers; the weaknesses of the former are well known, but there is sometimes a tendency to over-emphasise these weaknesses and to ignore the many advantages of a completely self-contained receiver. In any case, the great British public has signified its approval of this type of set in an almost unqualified manner, so it must have a very real appeal. Possibly it will eventually be displaced by the " mains transportable," which, with obvious limitations, has its advantages without its handicap of a limited power output and a rather heavy upkeep cost



The possibilities of " chassis " receivers, suitable for mounting in existing pieces of furniture, etc., should not be overlooked. Several examples of this type of construction are available commercially.

Recent articles dealing with the trend of modern receiver design show that a three-valve combination of H.F. amplifier, detector, and L.F. valve—very often a pentode is provided in the latter position—is the most popular circuit arrangement of to-day—at any rate for fixed receivers. It will be generally agreed that public taste is thoroughly well justified in this matter, and that for average requirements such a set is a safe choice. It has inherent freedom from serious L.F. instability, is at least reasonably selective, by virtue of its two or sometimes three tuned circuits, and is sufficiently sensitive for use almost anywhere for reception of the nearer stations with a consistent " programme " value, while the better designs can be depended upon for long-distance reception when conditions are reasonably favourable, particularly after dark.

Desirable Points in Design.

A four-valve receiver, with one H.F. amplifier and two L.F. stages, will have a greater reserve of amplification and is consequently to be recommended for more difficult situations and more exacting requirements. It is nowadays considered almost essential that such a set should have a post-detection volume control whereby the very considerable magnification afforded by its two L.F. stages may be reduced. Similarly, it is desirable that specific precautions should be taken to prevent undesirable interaction between the various anode circuits: at the best, such interaction will be productive of more or less serious distortion, and, at the worst, will cause motor-boating or L.F. oscillation. To minimise the possibilities of these troubles there is a tendency to rearrange the valves, and to provide two H.F. amplifiers with a single L.F. stage. Sets of this

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On Choosing a Set.—

type are rather more difficult to design and operate, but are more sensitive to weak inputs, and also much more selective. On the other hand, the H.F.-det.-2 L.F. combination scores where a very great power output is required. Sets with parallel or push-pull output valves come in this category, as they include the same number of stages.

The "two-H.F." set considered above is quite suitable for use with a frame aerial, and should have ample sensitivity for reception of stations near enough and powerful enough to provide consistently good signals. Due to the comparatively poor pick-up of this type of collector, regular long-distance reception implies either two stages of exceptional efficiency, or, better, of three H.F. valves. This brings us to the luxury class of set, whether for open aerial, frame, or short indoor aerial, with a multi-stage high-frequency amplifier having comparatively flat circuits, and, more often than not, a system of mechanically linked variable condensers. For consistent long-distance reception, this is unquestionably the best type of receiver.

Reverting to the question of selectivity, mention should be made of a point likely to be overlooked in deciding upon a receiver for operation near a twin regional station. This concerns input volume control; it is highly desirable that some means of regulating the signal voltage applied to the first valve should be provided. Detuning may not be permissible, due to the fact that a sufficient variation of the condenser capacity would probably bring in the unwanted alternative station. The ideal input volume control does not seem to exist, but very effective regulation can be arranged by providing variable coupling for the aerial.

TRANSMITTERS' NOTES AND QUERIES

Transmissions on 5 Metres.

Tests on the 5-metre waveband are being carried out from G6XN and G5QB throughout December and January at the following times :—

Each Sunday, 10.00-10.10, 10.30-10.40, 11.00-11.10, 11.30-11.40, 14.00-14.10, and for ten minutes past each subsequent hour and half-hour until 22.40 G.M.T.

Transmissions will take place alternatively from G5QB and G6XN, and will consist of series of Vs followed by the call-sign, or of the word "Test" followed by the call-sign, and an announcement of the frequency.

In addition, automatic signals will be sent from G5QB between 9 p.m. and 10 p.m. on each weekday from Monday to Friday inclusive.

Reports should be sent direct to G6XN, 5, Pembroke Mansions, Canfield Gardens, London, N.W.6, or to G5QB, 120, Mill Lane, London, N.W.6.

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Paris Experimental Station.

A French short-wave station which is now being heard in Great Britain is Paris Experimental Radio. Transmissions of gramophone records and speech are made on 31.65 metres (9479kC.) with a power of 1 kilowatt, four days a week at the following times : 10.00-11.30 a.m. G.M.T. Sunday, 21.30 Tuesday, 18.00-19.15 Thursday, and at 19.00 on Friday. The interval signal adopted is that of a metronome with 120 beats per minute. The station closes down with the playing of the well-known French military march, "Entre Sambre et Meuse."

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Federated Malay States.

Mr. G. D. Forbes (VS 2AT), writing from Kinta Kellas Estate, Batu Gajah, tells us that a Radio Society is being formed in the Federated Malay States, and that it is hoped to institute a broadcasting service. We gather from the correspondence which has passed between us that experimenters in the Malay States are few in number and somewhat widely scattered, but that their enthusiasm is almost unbounded.

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South Africa.

With reference to the note on page 417 of our issue of October 9th, we hear that Mr. E. R. Cook (ex G6UO) has been allotted the call-sign ZU1J, and that his present address is 6, Annandale Street Gardens, Cape Town. He generally works on the 21-metre waveband every Wednesday at about 16.00 G.M.T., and would greatly appreciate reports from anyone hearing him in this country.

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French Experimental Transmissions.

The French National Meterological Office, in collaboration with the Administration of Posts and Telegraphs, transmits twice in each month a series of signals on various wavelengths for the purpose of obtaining records of the signal-strength of the respective wavelengths in different parts of the world. The transmitting stations are Lyons FYS, with an aerial output of about 500 watts; Lyons FYR, with 6 to 10 kW., and Paris FLE, with about 1 kW.

The December series is from Paris only; the transmissions on December 12th will comprise only the 1st, 3rd and 6th groups, and that on December 14th the complete series. Each transmission will consist of repetitions of the signal . . — . . interspersed with groups of five figures, continuing for nine minutes, and followed by five minutes of telephony, one of the objects of the test being to discover the regions where distortion of speech occurs.

The series consists of :—

1st group, 11.40-11.54 G.M.T. on 24 metres, 11.55-12.09 on 36 metres, 12.10-12.24 on 56 metres, and 12.25-12.39 on 95 metres.

The succeeding groups are similar. The second group will be transmitted from 13.40-14.39, the third from 15.40-16.39, the fourth from 17.40-18.39, the fifth from 19.40-20.39, the sixth from 21.40-22.39, and the seventh from 23.40-00.39.

On January 11th and 18th of next year both the Lyons and Paris stations will transmit, this time on telegraphy only, the signals being repetitions of . . — . . interspersed every two minutes with the call-sign and an indicating group of five figures. The programme for the first group will be :—

12.00-12.10 G.M.T. Lyons FYS on 38 metres 12.10-12.20 Lyons FYR on 38 metres, 12.20-12.70 Paris FLE on 36.7 metres, 12.70-12.40 Lyons FYS on 25.75 metres, 12.40-12.50 Lyons FYR on 25.75 metres, 12.50-13.00 Paris FLE on 73.5 metres, 13.00-13.10 Lyons FYS on 15.1 metres, 13.10-13.20 Lyons FYR on 60 metres.

The succeeding three groups will be similar, and will be transmitted at the following times : 2nd group at 14,00-15.20; 3rd group, 16.00-17.20; 4th group, 17.70-18.50. The 5th group at 19.20 and the 7th at 23.30 will comprise Lyons FYR on 60 metres, Lyons FYS on 38 metres, Lyons FYR on 38 metres, Paris FLE on 36.7 and 73.5 metres, Lyons FYS on 25.75 metres, and Lyons FYR on 25.75 metres, each transmission lasting ten minutes; the 6th group at 21.20 will omit transmissions from Paris. The tests on January 11th will only include groups 1, 3 and 6, but those on January 18th will be in full.

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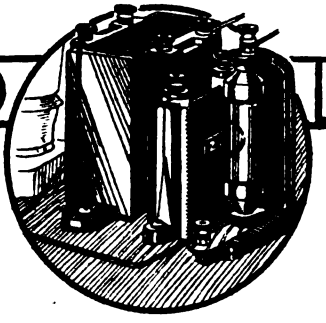
THE PARALLEL-FEED L.F. AMPLIFIER



How Resistance-condenser Coupling Affects the Transformer Characteristic.

By F. AUGHTIE, Ph.D., M.Sc.
and
W. F. COPE, B.A.

THE modern tendency in the design of receivers is towards simplification of external connections and improvement of the quality of reproduction. The introduction and increasing use of the anode feed resistance scheme has contributed to both of these by eliminating the need for tappings on the H.T. supply and reducing the back coupling caused by its resistance. In the case of high-power receivers, the resistance plays a further part in that it reduces the voltage of the H.T. from the high value required for the last stage, to a value more suitable for the earlier valves.

LOW-FREQUENCY intervalve transformers with high permeability cores are becoming increasingly popular, due to good performance combined with small physical dimensions. The steady anode current must, however, be deflected from their primary windings by a suitable resistance capacity filter, the practical study of which forms the subject of this article. The small disadvantages of the arrangement are undoubtedly outweighed by the advantages, not the least of which is freedom from motorboating.

When a valve is followed by a transformer and the H.T. voltage is such as to permit (or demand) the use of a resistance in series with the H.T. supply, an improvement of the results obtained may be given by rearranging the actual components used, together with a more exact choice of their values.

The actual circuit of the rearrangement is shown in Fig. 2b. Contrasted with Fig. 1, which shows the usual layout, it will be seen that the only wiring changes are as follows:—First, the lead from the resistance to the transformer is transferred from one terminal to the other, giving Fig. 2a; secondly, the order of the condenser and transformer is reversed. This second change has no effect on the electrical constants of the circuit, and is made solely to isolate the transformer from the H.T. supply: it can be omitted if desired. But the change from Fig. 1 to Fig. 2a, while simple on paper, profoundly alters the performance of the assembly in ways which it is the purpose of this article to explain.

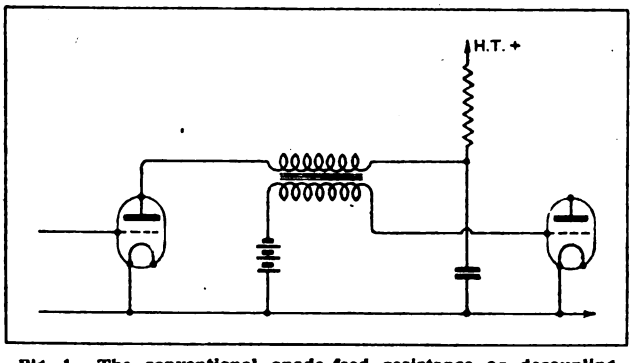


Fig. 1.—The conventional anode-feed resistance or decoupling scheme applied to a L.F. transformer stage to prevent feedback.

First of all, it should be noted that in Fig. 2a the D.C. feed current of the valve flows only through the resistance and *not* through the primary of the transformer as well. The immediate result of this is that the primary self-inductance of the transformer is not reduced from its "open circuit" value, as is the case when the steady current flows through the primary, and as a consequence—quite apart from other effects which will be discussed later—the amplification is maintained down to a lower frequency. In other words, the lower "cut-off" frequency is reduced in value.

With modern transformers tolerating little—if any—polarising current, and modern valves taking larger and larger anode currents, this factor alone is sufficient to warrant serious consideration for the change.

But there is a second effect which even further improves the performance at low frequencies. It is well known that a valve when amplifying may be regarded as a source of (alternating) E.M.F. in series with a resistance equal to its anode slope resistance ("impedance"). This permits us to draw the circuit of Fig. 2 in the form of Fig. 3, where the voltage μe in series with a resistance R_a replaces the valve. Now ignoring for a moment the effect of the resistance R, it will be seen that the transformer primary and the condenser are in series across the valve; the resistance R representing the transformer primary resistance. We see that we have our old friend the tuned circuit once more with all quantities much larger than are encountered in ordinary (R.F.) tuned circuits. The first impression therefore is that the arrangement will be selective, amplifying one frequency very strongly and others weakly. This will be so if the components are wrongly chosen, but by a suitable choice of values (all practicable) quite a different result may be obtained.

The ideal result is that, for a constant input voltage to the grid of the valve, the voltage applied to the grid of the succeeding valve shall be the same at all

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The Parallel-fed L.F. Amplifier.—

frequencies: this means that (for medium and low frequencies with which we are solely concerned in this treatment) the voltage across the primary must be independent of frequency. This is obtained if the (audio-frequency) current is inversely proportional to the frequency. This occurs with the normal circuit (over the usual frequency range) by letting the current be limited by the impedance of the primary, which, of course, increases with frequency, that is, by making R_a small compared with the impedance of the transformer primary. This is merely a long way of saying that the voltage across R_a must always be small.

The amplification can be maintained at its steady

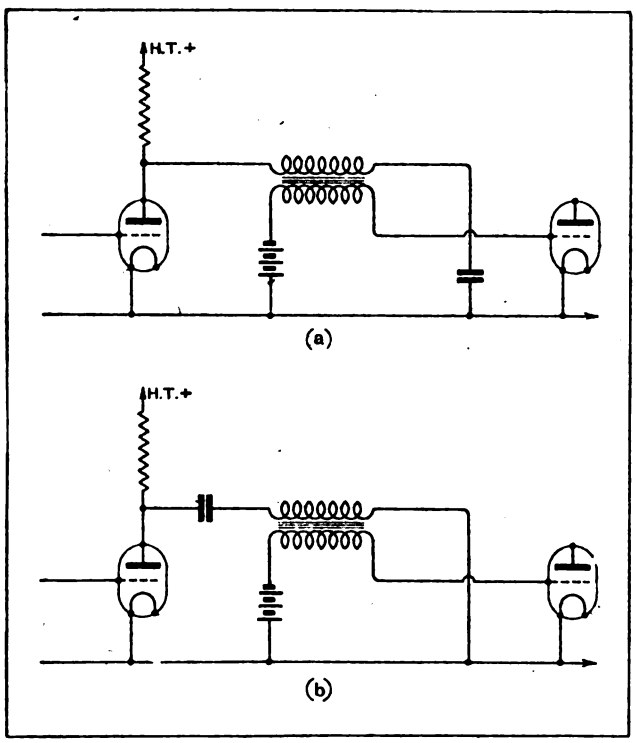

Fig. 2.—(a) The first step in the conversion of the circuit of Fig. 1 to a resistance filter-fed stage where the D.C. is prevented from passing through the transformer primary. (b) The complete conversion.

value down to a lower frequency if as the frequency is reduced an extra voltage be applied to the transformer primary additional to that at the output terminals of the valve. Now this is just what the condenser does in the circuit of Fig. 2, since when a condenser and inductance are placed in series across an alternating voltage, this applied voltage is the (arithmetic) difference between the voltage across the condenser and inductance respectively. Hence at least one (and not infrequently both) are greater than the applied voltage.

Looking at the performance from another point of view, the condenser reduces the impedance of the circuit and thereby permits a larger current; this gives an increased voltage across the transformer. The reduction of the impedance given by the condenser increases as the frequency decreases (down to a limiting point), and this can be made to compensate to a considerable extent for the drop of voltage across Ra, which, of course, also increases as the current increases.

This all looks so much like getting something for nothing that the reader is probably wondering "Where is the catch?" The catch is simply that the amplification is slightly reduced—unless an unlimited H.T. voltage is available! This is due to the resistance R now being a shunt with the primary of the transformer. We can see its effect by forgetting for the moment the condenser and transformer primary; redrawing the circuit (Fig. 4), it is seen to be the usual resistance coupling arrangement, the output voltage of which is known to be $\frac{\mu eR}{R+Ra}$, which is obviously less than μe. Now, looking at the complete diagram once more we see that it is this reduced voltage which is applied to the transformer through the condenser. As the "boosting" effect of the condenser only affects the low frequencies it is clear that at medium frequencies the amplification is reduced.

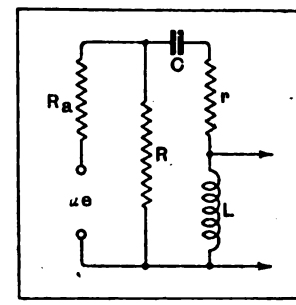

Fig. 3.—A valve when amplifying should be regarded as a source of alternating E.M.F. in series with a resistance equal to its anode A.C. resistance. The equivalent circuit of Fig. 2 is here shown.

The loss of amplification can be made small by making R large, but unfortunately this means using large H.T. voltages, and in practice a compromise has to be made. The average reduction is 20 per cent., an amount which is too small to be detected by the average ear.

Avoiding a Resonant Circuit.

Hanging over our heads all this time is the "tuned circuit" threat mentioned at the commencement. Fortunately the mathematical analysis of the circuit shows how this can be avoided and gives quite a simple formula connecting the constants of the circuit. The full analysis is somewhat beyond the scope of the present paper. The design formula is given in the Appendix.

Note that the steady value of the amplification over the useful range is $\frac{1}{B}$ times that obtained with the usual circuit. When the constants of the circuit satisfy this relation the amplification curve rises smoothly up to the value at medium frequencies without rising above this value, i.e., there is no hump in the curve. It is important to note that the value of L to insert in the formula is the open-circuit inductance of the transformer primary. This is the value usually

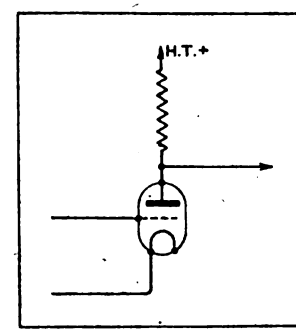

Fig. 4.—The normal resistance coupling arrangement in which the stage amplification must be less than the amplification factor of the valve.

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The Parallel-fed L.F. Amplifier.—

given in the maker's specification unless otherwise stated.

In practice the values of the constants will deviate from their "nominal" values given by the makers; fortunately this causes no serious modification of the coupling efficiency-frequency curves, as may be seen from Figs. 5, 6 and 7, which shows the effect of such deviation from the nominal values as are likely to occur in practice.

As the usual tendency is for Ra to be greater than the rated value, and L to be less, a smaller value of condenser than that given by the formula is often satisfactory. This is cheaper and causes no serious modification of the curve. A value of three-quarters of that given by the formula is suggested as being satisfactory in most cases.

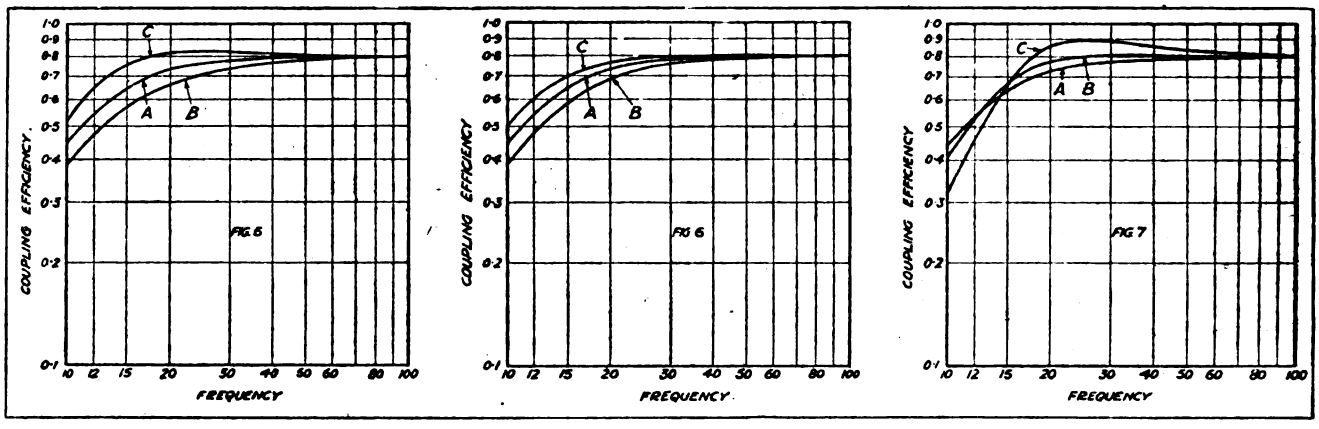

Fig. 5. Fig. 6. Fig. 7.

Figs. 5, 6 and 7.—Coupling efficiency-frequency characteristics. In Fig. 5 the effect of varying valve resistance is shown. Curve A is for a nominal resistance of 5,000 ohms; curve B for 20 per cent. increase and curve C for 20 per cent. reduction (i.e. 6,000 and 4,000 ohms respectively). C = 4 mfd.; L = 45 henrys; R = 20,000 ohms. Fig. 6.—The effect of varying inductance. Curve A = 45 henrys; B = 11 per cent. reduction = 40 henrys; C = 11 per cent. increase = 50 henrys. R_a = 5,000 ohms; R = 20,000 ohms; C = 4 mfd. Fig. 7.—Varying capacity values. Curve A = 4 mfd.; B = 25 per cent. reduction = 3 mfd.; C = 50 per cent. reduction = 2 mfd. R_a = 5,000 ohms; R = 20,000 ohms; L = 45 henrys.

To facilitate design, in Fig. 8 a number of curves have been prepared showing the correct coupling condenser for various primary inductances and valve resistances.

A further set of curves, Fig. 9, gives the corresponding cut-off frequencies. The cut-off frequency is defined as the frequency at which the amplification has fallen to 70 per cent. $\left(\frac{1}{\sqrt{2}}\right)$ of its value at medium frequencies.

It will be noted that figures are given for low-resistance valves; this is because the circuit is particularly suitable for the penultimate stage of a high-power receiver where considerable grid swing is required for the output stage.

There is one other feature of the circuit to which reference may profitably be made. It can be shown that the magnitude of the audio-frequency current flowing through the H.T. supply falls as the

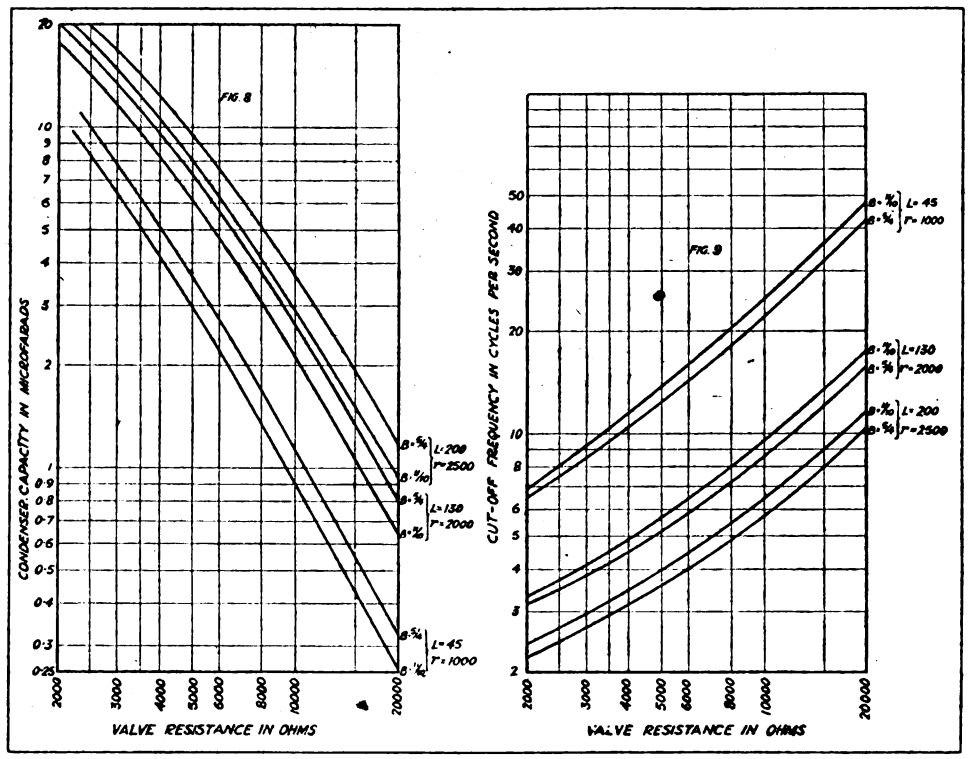

Fig. 8. Fig. 9.

Fig. 8.—Showing the correct coupling condensers for various primary inductances and valve resistances. Fig. 9.—How varying valve resistance affects cut-off frequency.

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The Parallel-fed L.F. Amplifier.—

frequency is reduced down to the cut-off frequency. This is of importance because the internal impedance of practically all eliminators rises as the frequency is reduced. The circuit shown is therefore free from "motorboating" under ordinary conditions, but the usual choke-filter should be retained in the last stage.

Cut-off Frequency Considerations.

The rise of audio-frequency current through the H.T. supply for frequencies below the cut-off is of little importance because the amplification is very small at these frequencies. There is therefore no tendency to oscillate at a frequency below this value.

APPENDIX.

The design formula is:—

$$C = 2L\left(\frac{B}{A}\right)^2, \qquad \text{Where } A = R_a + r + \frac{R_a}{R} r = R + Br$$

$$B = 1 + \frac{R}{R}$$

The amplification at any frequency is given by

$$\frac{\mu.\sigma\ \omega L}{\sqrt{A^2 + B^2\left(\omega L - \frac{1}{\omega C}\right)^2}}$$

Where in addition to the above:—$\omega = 2\pi \times$ frequency, $\mu =$ amplification factor of valve, $\sigma =$ voltage ratio of transformer.

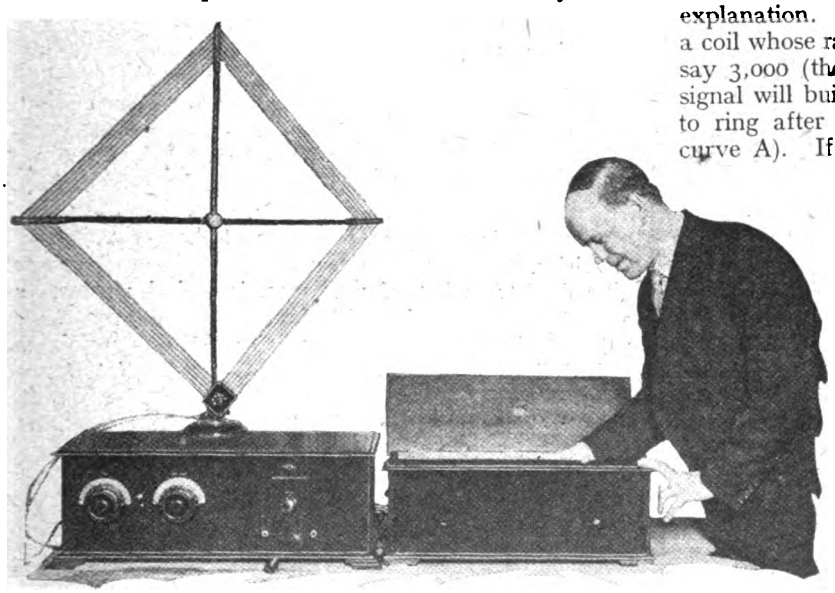
Except at high frequencies the product $\mu.\sigma$ is constant, and thus we are concerned mainly with the third factor. This is conveniently termed the "Coupling Efficiency."

THE ROBINSON "STENODE RADIOSTAT."

A Receiving Set Designed to Separate Two Stations One Kilocycle Apart.

THE WIRELESS WORLD has recently been afforded an opportunity of inspecting a remarkable receiving set designed by J. Robinson, D.Sc., the former head of the Wireless Section of the Royal Air Force, embodying a new circuit system for selective reception known as the "Stenode Radiostat." It is understood that, owing to the patent situation, details cannot be disclosed at present, but the performance of the apparatus seems to show that Dr. Robinson has succeeded in producing a device of unusual selectivity combined with good quality of reproduction.

The set consists of two cabinets, one of which is sealed, while the other is fitted with a variable tuning condenser for coarse adjustment, and a small fine-control air condenser for accurate setting. The maximum variation possible with the latter is only about 6 mmfd., and a change of a fraction of 1 mmfd. brings in 2LO strongly, so that the selectivity is enormous. In spite of the great selectivity, the quality of reproduction is as good as could be desired.



The selectivity produced is demonstrated by a superheterodyne provided with a fine-tuning condenser of exceedingly small capacity connected across the oscillator control. An interfering signal from an H.F. oscillator while producing a heterodyne note on a normal receiver is readily removed and a broadcast transmission received with good quality. Dr. Robinson is seen examining the crystal controlled unit.

In order to test the effect of an interfering transmitting station, a local oscillator was set up to give a heterodyne note with 2LO. This note could be clearly heard on an ordinary receiver, but no trace of it appeared with Dr. Robinson's set, even when the local oscillator was tuned to a frequency only 1 kilocycle off 2LO. It was not until the heterodyne note dropped to a frequency of 300 or 400 that it began to cut into the broadcast.

A Partial Explanation.

Dr. Robinson has supplied a few details, which amount to a hint as to the method which he uses rather than an explanation. If we construct a tuned circuit containing a coil whose ratio of reactance to resistance is very large, say 3,000 (the amateur's usual figure is 150), then the signal will build up slowly, and the circuit will continue to ring after the incoming signal has ceased (Fig. 1, curve A). If, however, we chop the wave into equal sections and reverse the phase in each alternate section, the energy which builds up in the receiving tuned circuit during one section will be completely destroyed during the next, owing to the phase reversal (Fig. 1, curve B). The circuit evidently remains as selective as ever, that is, the shape of the usual resonance curve is unaltered, but the sluggishness has been greatly reduced as curve B shows, while the amplification is smaller.

Fig. 2 shows how the incoming wave is chopped. Two screen-grid valves in parallel receive the incoming signal in opposite phases. This arrangement would, of course, neutralise the signal, and no effect would be transmitted to the detector valve. A device is added which is the essence of the affair. *The*

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The Robinson "Stenode Radiostat."—
two screens are wobbled up and down at supersonic frequency, and hence the valves come into action alternately. A train of waves is transmitted by one valve

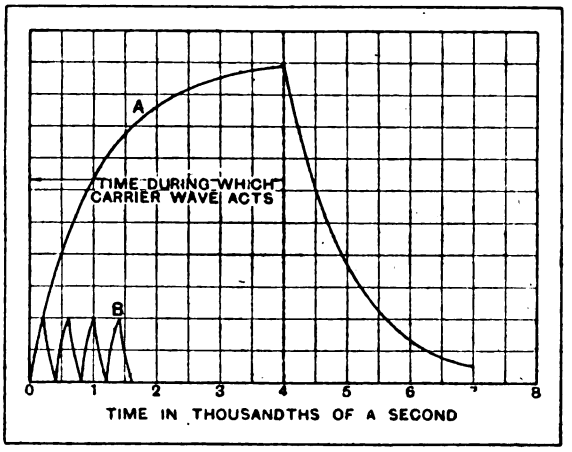

Fig. 1.—(a) Signal given by a tuned circuit of magnification 3,000 when receiving waves on 300 metres. (b) Signal produced by the same circuit when the incoming wave is chopped with reversal of phase at each interruption.

when its screen is up; on the next wobble this valve shuts down, and the waves come through the other valve with a reversal of phase.

Still a Mystery.

The above explanation certainly discloses an ingenious method by which ringing might be prevented on a set of high selectivity, but it does *not* explain why the sidebands in broadcast transmission get through on such a set. We are still puzzled by the result that an interfering station 1 kc. away is cut out, while the quality of reproduction would suggest that sidebands up to 5 kc. away may be getting through. It is to be hoped that Dr. Robinson will explain this phenomenon at an early date.

While this new circuit system appears to have numerous important applications, Dr. Robinson claims that it is now possible to establish some fifty broadcast stations in an area where only one transmitting station can operate under existing conditions. Broadcast

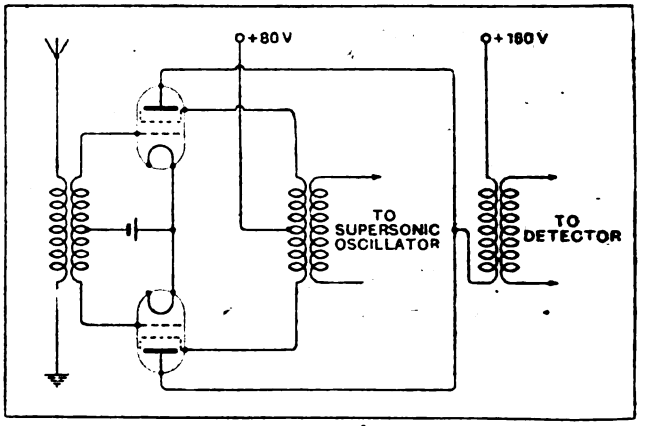

Fig. 2.—The signal is received in opposite phase by two parallel-connected screen-grid valves. A supersonic oscillator connected in the leads to the screen grids upsets the balance and brings the valves alternately into action. In the demonstration apparatus the screen-grid valves follow the intermediate amplifier of a superheterodyne receiver, and the supersonic oscillator is a piezo-electric crystal.

receivers, it is stated, can be constructed at popular prices which will receive existing programmes without mutual interference.

CHRISTMAS RECORDS.

A Good Selection of Seasonable Music.

THE increasing number of readers who employ electrical methods for the reproduction of gramophone music adds special interest at this season to the selection of Christmas records which have just been issued by Columbia. We have had the opportunity of testing a number of these, and consider that they are a most attractive series.

An exceptionally fine record is one entitled "An Organist's Yuletide," which is contributed by Mr. Quentin MacLean, the organist of the Regal Cinema, London. It is a fine example of modern recording, and consists of a delightful Christmas medley, including snatches of carols and traditional tunes.

Savoy Christmas Medleys, a record which has had great popularity in the past, has been remade this season by Debroy Somers' band.

A particularly fine record by the Ketelby Concert Orchestra, with W. G. Webber playing the organ of Westminster Central Hall, and Nellie Walker singing with a full chorus, is "A Dream of Christmas." The theme is that it is Christmas Eve, and the mother has been relating bedtime stories to her little child, who afterwards falls asleep and dreams of the carol singers and fairies.

The Christmas list of new records includes some of the most popular carols and hymns, beautifully rendered by the St. George's Singers. They are six in number, and include "We Three Kings of Orient Are," "Wassail Song," "What Child is This," "The Moon Shines Bright," "I Saw Three Ships," and "The Holly and the Ivy." Three carols are contained on each record. All are sung unaccompanied, and those who have heard the madrigal records of this talented body of singers will not need to be told how beautifully the carols have been performed. The B.B.C. Choir and Wireless Military Band have also contributed to the Christmas vocal list with "Once in Royal David's City" and "While Shepherds Watched," and the fullness of tone produced by choir, band and organ makes an interesting contrast to the simplicity of the St. George's singers.

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How we Hear

Can the Principles of Mechanism by which the Ear Detects Sounds of Varied Amplitude and Frequency be Applied in Radio?

By R. T. BEATTY, M.A., B.E., D.Sc.

IF a committee of scientists and engineers were asked to design an instrument which would be sensitive to all audible tones, which would detect a change in pitch of less than a sixtieth of a semitone over most of the range, and register changes in loudness of the order of 10 per cent., which would be capable of operating a relay in response to the chirp of a cricket or the roll of thunder, and, lastly, work day by day for some fifty years without attention, executing its own repairs, keeping itself clean, and costing a penny per day for running expenses, what sort of machine would the committee recommend to satisfy these terrifying demands embracing so many exacting conditions?

No such machine would be produced.

But if thought were taken for the first four conditions only, a solution could be arrived at. One would imagine that it would take a form of long racks carrying some twenty thousand resonators —64 to the semitone over the musical range—with a tiny coil of heated wire in the neck of each resonator to be alternately warmed and chilled by the throb of sound. Each coil would be connected to a valve amplifier, and the output wires would be led through a maze of switches to an inconceivable number of relays.

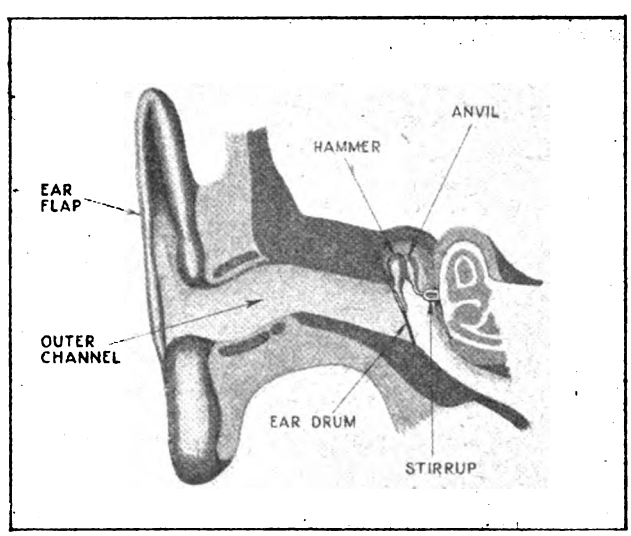

Fig. 1.—Sound is collected by the ear flap, passed along the outer channel, and transmitted via the ear drum and the hammer, anvil, and stirrup, to the oval window shown in Fig. 2.

The whole affair would cost a million pounds; it would be served by thousands of operators, and would fill the great hall at Olympia.

Nature's Curious Device.

Nature, working by her savage formless methods over a space of many million years, advancing by trial and error, with life or death to mark success or failure, has solved the problem. Those who have ears to hear are drawing their royalties on Nature's invention.

What, then, is her solution?

It is the little affair like a snail shell with a bundle of nerve fibres passing from it to the brain; the whole thing could be enclosed within the shell of a hazel nut, and the nerve bundle with its thousands of fibres could be threaded through a tube of macaroni.

It is music's analyser; the brain is its interpreter; and the partnership is one of the sweetest gifts which has been given to man.

The snail shell, or cochlea, consists of a hollow tube of bone coiled into a spiral of 2¾ turns and filled with liquid. In all mammals, with but one exception, this spiral shape is found, but if we imagine that man, who is distinguished for the number of convolutions in his

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How We Hear.—

brain, is similarly favoured by possessing the greatest number of turns in his cochlea, we are at once humiliated by the fact that pride of place must be given to the common pig, with 3½ turns.

The cochlea if uncoiled would appear as a straight tube 30 mm. long with an average internal diameter of 1.5 mm. This tube is divided lengthwise into two parts by a tightly stretched membrane, the basilar membrane, which runs along its entire length.

One end of the long tube is enlarged and is fitted with two thin membranous windows; one of these, the oval window, carries a piston which conveys the vibrations of sound from the outer ear; the other, the round window, relieves by its motion the pressure set up in the fluid by the motion of the piston.

Man's Miniature Harp.

Under the microscope the basilar membrane is seen to consist of some 24,000 tightly stretched fibres running crosswise, each fibre being held in tension by ligaments. These fibres are connected to each other by a thin membrane, and they increase in length from 0.13 mm. near the piston to 0.4 mm. at the other end of the tube. The whole structure irresistibly suggests a set of tuned

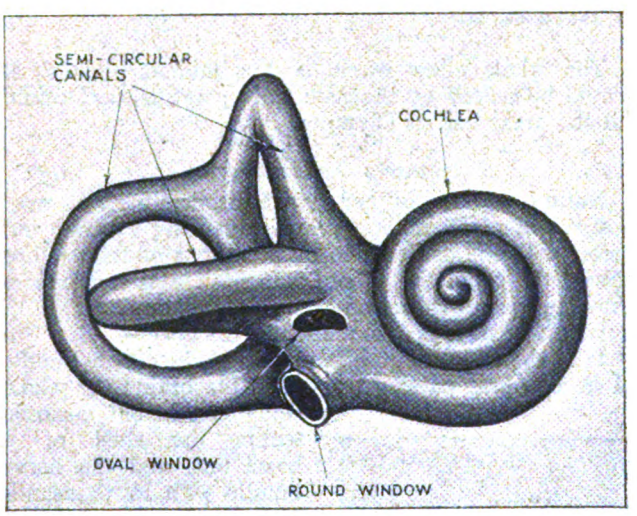

Fig. 2.—The stirrup (Fig. 1), which is attached by a membrane to the oval window, transmits vibrations to the fluid filling the cochlea, across the basilar membrane, and back along the cochlea to the round window.

strings, and all the facts patiently unearthed by anatomists and physicists confirm the conviction that this is indeed Nature's harp which, by the resonance of its strings, analyses the vibrant messages from the external world. Thousands of years before the first savage crouched to evoke rude music from his bowstring, this marvellous instrument lay fully developed in the ears of mankind ready to interpret the rustle of leaves, the song of birds, the roar of the carnivore, to the still lowly brain, deaf as yet to all but material needs.

The Ear as a Whole.

The ear flap (Fig. 1), which is now but a rudimentary collector of sound waves, compared with the large mobile ears of the horse or the dog, passes the sound down the outer channel to the ear drum which actuates a chain of three bones—the hammer, anvil, and stirrup—the three forming a lever system with a reduction in amplitude of 1½ to 1. The end of the stirrup is inserted

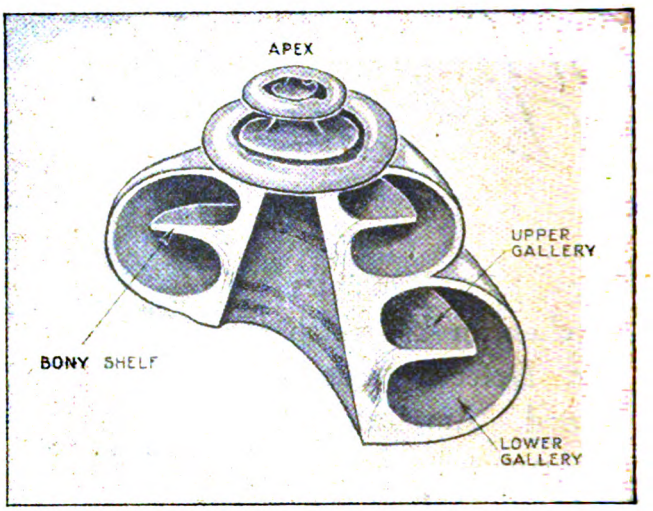

Fig. 3.—Cross-section of the bony cochlea: the basilar membrane is not shown.

into the membrane which closes the oval window (Fig. 2) of the bony labyrinth. In addition to the cochlea three curious formations will be noticed looking like handles. These have nothing to do with hearing, but give us information about our position in space, and guide our movements in turning, leaping, or bending. They form the oldest part of the ear; they are found, but with no cochlea attached, in fishes, which do not need to hear, but whose life depends on their ability to make accurate and well-timed movements.

A cross-section of the bony cochlea is shown in Fig. 3. A spiral tube winds upwards to the apex, and is almost divided in two by a spiral bony shelf; one end of the basilar membrane is attached to the edge of this shelf (Fig. 4), and stretches across to the opposite side where it is held in tension by a strong ligament, so that the spiral tube is actually divided into an upper and a lower gallery.

The Simplified Ear.

A mechanical model, Fig. 5, may be constructed to represent what is generally believed to be the mode of action of the ear. When a puff of air strikes the outer ear the drum and the lever system move forward so that the stirrup transmits pressure to the liquid in the upper gallery; the motion is communicated through the opening at the apex to the lower gallery, and the round window bulges slightly in consequence. In addition, of course, the pressure may be partly relieved by yielding of the basilar membrane, and if a pure tone of given frequency is used we would expect that any portion of the basilar membrane which is tuned to this frequency would be set into resonance, and convey a message to the brain by the nerves which are attached to it. This indeed was the original brilliant suggestion of Helmholtz, and is a remarkable instance of scientific foresight. He recognised that the only known way of analys-

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How We Hear.—

ing complex sounds was by the use of resonators, and that the transverse fibres of the basilar membrane, with their progressive variation in length, might act as a system of this kind.

Three Points which Support the Resonator Theory.

As we pass along the spiral tube of the cochlea from base to apex, we find that the fibres of the basilar membrane increase in length from 0.13 mm. at one end to 0.40 mm. at the other. Further, the spiral ligament which holds the membrane taut decreases in bulk from base to apex; near the apex, indeed, it consists of only a few thin fibres. Again, when resonance is set up in any section of the membrane, the mass moved is not only that of the membrane, but also that of the double column of liquid, as shown in Fig. 6, so that the loading of the fibres increases from base to apex.

Now, the formula for the frequency of vibration of a stretched string is:—

$$\text{Frequency} = \frac{1}{\text{twice length}}\sqrt{\frac{\text{tension}}{\text{mass per unit length}}}$$

and we have just seen that in going from base to apex *length* and *mass* increase while *tension* diminishes. It appears, then, that all three factors vary as they should

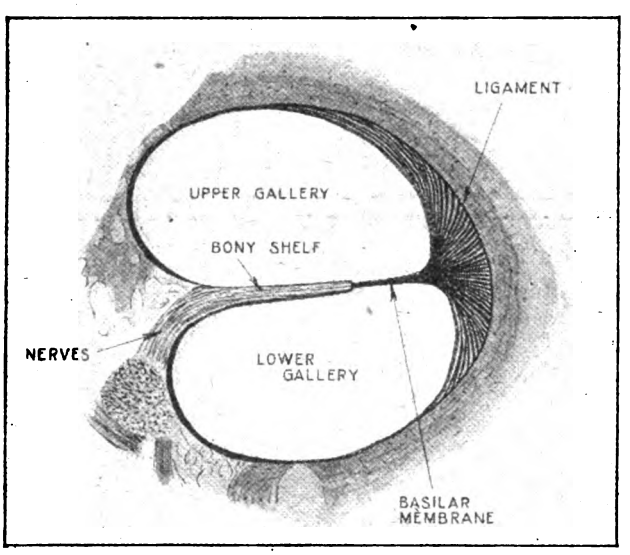

Fig. 4.—Cross-section of the cochlear galleries: the basilar membrane is held in tension by strong ligaments, and nerves run from it through channels in the bony shelf and are led away through the central opening shown in Fig. 3.

if the bass strings are to be located at the basal end and the treble strings at the apical end of the cochlea. Helmholtz was aware of but one of these factors; had the other two been known in his time few can doubt that the resonator theory would have been established so firmly that no rival theories would ever have emerged.

Can the Fibres Stand the Required Tension?

The greatest tension will be needed for the strings tuned to the highest audible frequency, which is about 30,000 cycles per second. Since we can find the length and mass from microscopical observations we can calculate the tension from the formula given above. It works out that we require a tension of 44 milligrammes to tune a single fibre to this note, taking the diameter of a fibre as 0.003 mm.

Now, it is found from experiments on animal tendons and fibres such as human hair or silkworm gut that

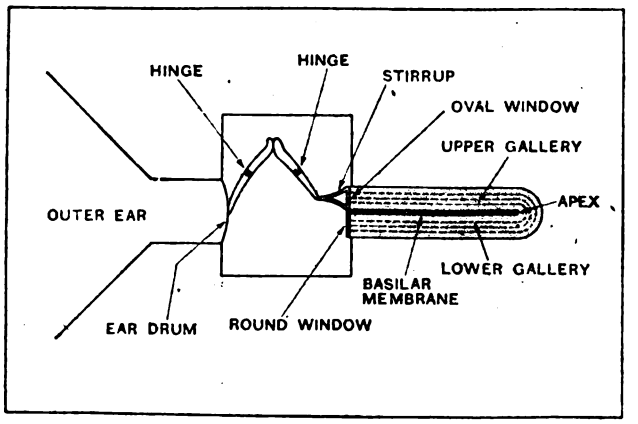

Fig. 5.—The action of the ear demonstrated by means of a mechanical model.

their breaking stress for the same cross-section is from four to eight times the figure just given. It seems, then, that the theory makes no impossible demands on the strength of the resonating elements.

Those who think in terms of the piano or harp may still, however, feel that an instrument on the cochlear scale is unworkable. The deepest string of the piano is several feet long, while the longest string of the cochlea is only 0.4 mm.; how can these ridiculously different lengths be tuned to the same note?

The answer is that the dimensions of the piano are large because the instrument is required to deliver a large volume of sound. The cochlear strings, on the other hand, need only vibrate through a few millionths of a millimetre to excite the nerve endings with which they are connected. Scale has nothing to do with the question of resonance; if we compensate for decreased length and mass by decreased tension we can pass to an instrument whose smallness is only limited by the size of the molecules themselves.

Experimental Evidence for the Resonator Theory.

Twenty years ago a remarkable experiment was carried out on the guinea-pig, which has a well-developed cochlea of four turns. A loud note was sounded close to the animal's hutch and maintained for many hours. The guinea-pig was then killed and its cochlea examined under the microscope, whereupon

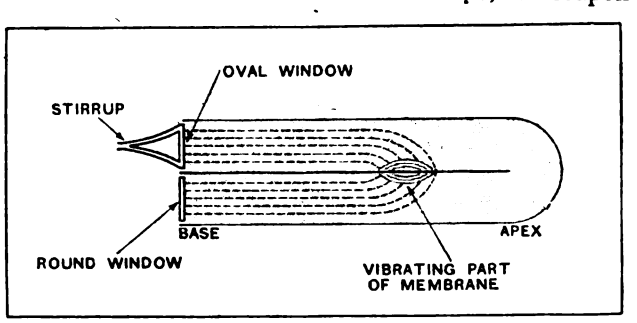

Fig. 6.—From this mechanical model it is seen that not only the membrane vibrates but also a double column of liquid, so that the loading of the fibres increases from base to apex.

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How We Hear.—

a portion of the basilar membrane was found to have degenerated, the same being true for the nerves attached to it. Similar experiments were carried out with notes of different pitches, and in all cases the position of the injured part depended only on the pitch of the note which had been used. Fig. 7 represents a section of the cochlea of the guinea-pig, and the positions of the injured areas are marked corresponding to the exciting frequencies. Below are shown the four turns of the basilar membrane uncoiled with the damaged portions shaded.

This experiment, through indicating that the membrane is differentiated for frequency along its length and that low notes affect the region near the apex, is not quite convincing, since in each case a long strip is injured, whereas we should expect the damage to extend over a few fibres only. However, the notes were excessively loud, so that probably a great many fibres were set into forced oscillation in addition to those which vibrated with their own natural frequency.

Last year results of a much more definite nature were obtained in a Leipsic laboratory. A very fine drill, only

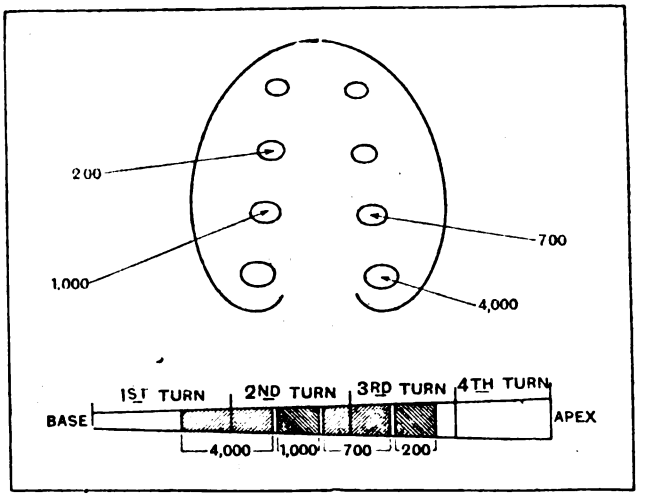

Fig. 7.—Section of a cochlea of a guinea pig, showing how different portions may become damaged by sounding notes of particular frequencies.

$\frac{1}{10}$ mm. in diameter, was used to bore a hole into the wall of the bony cochlea so as to break some threads of the ligament which exerts tension on the basilar membrane (Fig. 8). Subsequent microscopical examination showed that neither the membrane itself had been injured nor the nerves which pass from it and leave the cochlea on the opposite side from the point of entry of the drill. The tension, and consequently the natural frequency of the membrane, must, however, have been decreased.

It has long been known that the guinea-pig responds to any note within its range of hearing by a tremor of its ear muscle. Previous to the operation the animal responded in this way to all the notes of a series of tuning forks spaced a semi-tone apart from a frequency of 1,000 to 40,000 cycles per second.

After the operation a region of deafness was found whose position varied with the location of the drilled hole and which extended over a frequency breadth *not exceeding a single tone*. The positions of the holes in different experiments are shown at the bottom of Fig. 8 with the corresponding frequencies where deafness was noted by the absence of the ear muscle reflex.

It will be seen that the positions agree with the theory that the fibres are tuned to higher and higher frequencies as the base of the cochlea is approached.

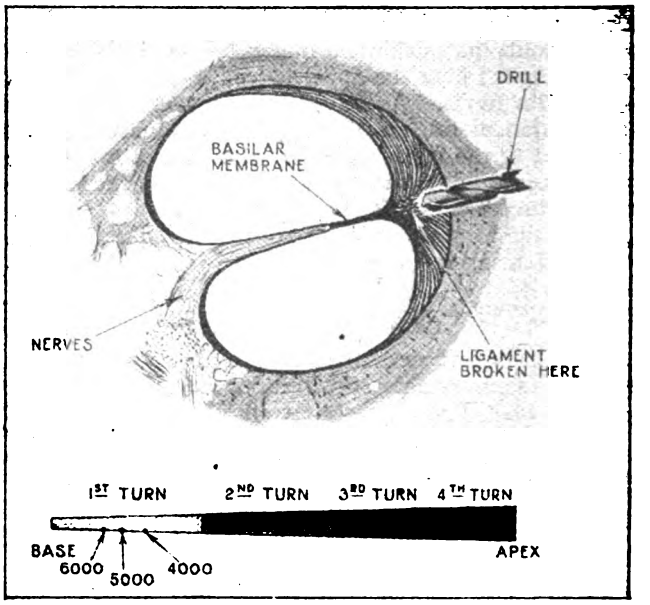

Fig. 8.—Breaking of some of the threads of the ligament which exerts tension on the basilar membrane produces a deafness over narrow bands of frequency.

The most remarkable fact of all is that the narrow band of deafness disappeared after three weeks. The ligament must have recovered its former tension, but that it should have done so, and applied exactly the right amount of pull to the corresponding elements of the membrane, seems to be a marvellous thing.

The Telephone Theory.

Though the resonator theory is so attractive and so powerfully supported by the facts which have been already cited it is not universally accepted. There are some who hold that the basilar membrane has no power of analysis, but that it faithfully follows every change in pressure of the sound waves and by its motion as a whole transmits messages to the thousands of fibrils which make up the auditory nerve. These fibrils accordingly act like telephone wires in parallel, and the onus of analysing the messages is thrown entirely on the brain.

If we accept this theory we must be puzzled by the complex structure of the basilar membrane; a much simpler device would seem to be adequate if no analysis is performed till the brain is reached: a few nerves attached to the ear-drum might suffice.

But a more formidable difficulty arises from the recent discoveries of physiologists as to the response of nerves to rapid impulses.

(To be concluded.)

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Broadcast Brevities

By Our Special Correspondent.

Twin Transmission on Trial.—The Modulation Question.—Appeal to Pirates.

Regional Scheme on Trial.

Before these lines appear the behaviour of the Brookmans Park transmitters working in double harness will have been ruthlessly scrutinised by legions of listeners. The B.B.C. is on trial; and I should be surprised if there were any recommendation for mercy if the scheme proved to be beyond the technical resources of the populace.

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Is 261 Metres Too Low?

For one hour and a half daily (Mondays to Fridays) the normal London programme is being broadcast on the wavelength of 261 metres, and many listeners have never yet descended to such a depth. The importance of becoming familiar with this wavelength is realised when one notes that it will be used for the "general interest or national programme."

The B.B.C. are wise in limiting the alternative transmission to speech; and it is also a shrewd move to allow an hour's transmission daily on the shorter wavelength without the encumbrance of the 356 metre signal.

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When to Listen.

The full schedule of tests, until further notice, is as follows:—

MORNING:	
11.30 a.m. to 12 noon (Monday to Friday inclusive).	5XX Programme on 261 metre wavelength.
12.30 p.m. to 1.0 p.m. (Saturday only).	* Special programme on the 261 metre wavelength and 5XX.
12.0 noon to 1.0 p.m. (Monday to Friday inclusive).	The normal published programme on the 261 metre wavelength.
1.0 p.m. to 2 p.m. (Saturdays only).	Special programme on the 356 metre wavelength.
1.0 p.m. onwards (Monday to Friday inclusive).	The 356 metre wavelength returns to the normal published programme.
2.0 p.m. onwards (Saturday only).	
EVENING:	
First half-hour of dance music period.	Dance music as published on the 261 metre wavelength only.
Remainder of dance music period.	Dance music as published on the 261 metre wavelength and special programme on the 356 metre wavelength.

* 5XX at all times does its normal published programme, in addition to the special programme on Saturday mornings

There will be no test transmissions on Sundays, Christmas Day and Boxing Day, but the usual programme will be radiated on 356 and 1554 metres.

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A Springtime Service.

The length of the tests is still a matter for debate in B.B.C. engineering circles, but I think that my original prediction, that we shall have the season of spring and portables upon us before regular twin programmes, will not be far wrong.

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Over-modulation.

The question of the modulation of B.B.C. transmitters, recently raised in *The Wireless World*, has excited considerable interest at Savoy Hill. That the B.B.C. stations are models of rectitude in this direction is proved, say the officials, by the news that the Union Internationale de Radiodiffusion is holding up the B.B.C. as an example to transgressors on the Continent. It appears that much of the trouble with the Prague Plan is definitely ascribed to over-modulation by European broadcasters. To those who froth over the Union says: "Look at 5GB and Brookmans Park. Mark the delightful manner in which they are received abroad."

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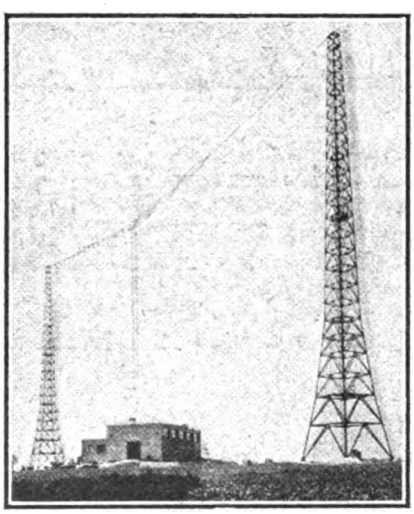
The Clapham Test.

At its Clapham research station on a recent Saturday, the B.B.C. conducted a little experiment in self-vindication, selecting the transmission of Radio Toulouse for the purpose. Radio Toulouse is an 8 kW station with an estimated aerial power of 5 kW. Signal measurement tests revealed a strength at Clapham of 0.8 millivolts per metre. Now, says the B.B.C., one of our stations operating on the same power would not yield a higher signal strength than 0.25 millivolts at such a distance. Therefore Radio Toulouse is over-modulating. Q.E.D.



HAVE YOU HEARD THIS ONE? The Czech station at Moravska-Ostrava, which is not difficult to receive in this country. The power is 10 kW and the wavelength 263 metres.

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The Decline of the Oscillator.

That the old breed is slowly dying out is shown by some revealing figures collected by the B.B.C. anent oscillation complaints. In October and November, 1927, complaints of oscillation numbered 2,204. In the corresponding period of 1928 the figure dropped to 1,603. This year it is only 1,551. The figures as they stand tell less than the truth, for in October, 1927, there were only 2,337,733 licensees as compared with 2,852,924 two years later.

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To the Radio Pirates of the World.

Oscillators and pirates are all nuisances, but in most cases there is a chasm of moral difference between the two classes.

The ordinary methods of overcoming piracy being rather slow, the B.B.C. might take a tip from the Polish broadcasting authorities, who are seeking to overwhelm the pirate by an appeal to his better nature. To-morrow (Thursday) the Vilna broadcasting station will broadcast a programme addressed to "the radio pirates of the world." In a special address to this ignoble fraternity, condemnation will be tempered with exhortations to repent. What stony-hearted knob-twiddler could stand this?

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British and German Licence Figures.

The human element asserted itself distressingly in a recent paragraph in which I stated that the increase in British receiving licences amounted to 17,025 in the previous quarter. This figure actually represents the *monthly* increase, so the comparison with the German quarterly advance of 16,941 sheds a yet more glorious light on the popularity of the B.B.C. programmes.

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The Microphone in Fleet Street.

Readers who wonder what Fleet Street is like and how a newspaper is produced should listen to the broadcast from 2LO and 5XX on December 16 of a tour of a newspaper office.

The Editor's room, the news room, the composing department, the foundry and the machine room will be visited.

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WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

Part XII.

A.C. Circuits with Resistance, Inductance and Capacity.

(*Continued from page 624 of previous issue.*)

UP to the present we have dealt with resistance, inductance and capacity singly and have discussed the laws applying to each as regards alternating currents. We have also considered the combined effects of inductance and resistance in series, where impedance and power factor introduced themselves. We have now to take into account those circuits in which capacity is present together with one or other, or both, of the constants resistance and inductance. As we have learned all the rules applying to each of the three constants individually, the solving of a circuit where two or all three of them are present merely resolves itself into combining the effects according to the known laws of each. In simple series or parallel circuits this is quite an easy matter, but for circuits where there are both series and parallel portions it is sometimes very difficult. Fortunately we need only concern ourselves with the simpler circuits to enable us to understand and deal in a practical manner with the great majority of circuit arrangements in a modern wireless receiver.

Capacity and Resistance in Series.

In the first place let us consider a circuit consisting of a resistance R in series with a condenser of capacity C as shown in Fig. 1 (*a*). Suppose that it is desired to drive an alternating current whose R.M.S. value is I amperes through the circuit. Then the total voltage required will be made up of two components, namely, that necessary to drive the current through the resistance R and that required to drive the current "through" the condenser C. (N.B.—The same current flows through each element of a series circuit.) Denote these voltages by E_1 and E_2 respectively, as shown in Fig. 1.

We have then $E_1 = IR$ volts, *being in phase with I* (rule for a pure resistance), and $E_2 = IX_c$ volts, *lagging behind I by a quarter of a cycle*, because for a condenser the current *leads* the voltage by 90°. X_c is the reactance of the condenser, its value being $\frac{1}{2\pi fC}$ ohms.

So if we draw a simple vector diagram for the circuit we must draw the lines OE_1 and OE_2 at right-angles to each other, as shown in Fig. 1 (*b*), where OE_1 is in line with the current vector OI. The total voltage required between the ends of the circuit is then given by the length of the diagonal OE. Thus

$$E = \sqrt{E_1^2 + E_2^2} = \sqrt{(IR)^2 + (IX)^2} = I\sqrt{R^2 + X_c^2} \text{ volts.}$$

It will be realised that this is the same expression as used for resistance and inductance in series, except that in the present case we have the condensive reactance in place of the inductive reactance. $\sqrt{R^2 + X_c^2}$ is the impedance Z of the circuit in ohms. A further difference lies in the fact that the current *leads* the applied voltage by an angle ϕ, where $\cos\phi = \frac{R}{Z}$ as before. For the inductive circuit it was a *lagging* angle. The impedance triangle for the circuit is shown at (*c*) in Fig. 1, the reactance line X_c being drawn vertically *downwards* this time because condensive reactance is negative with respect to inductive reactance.

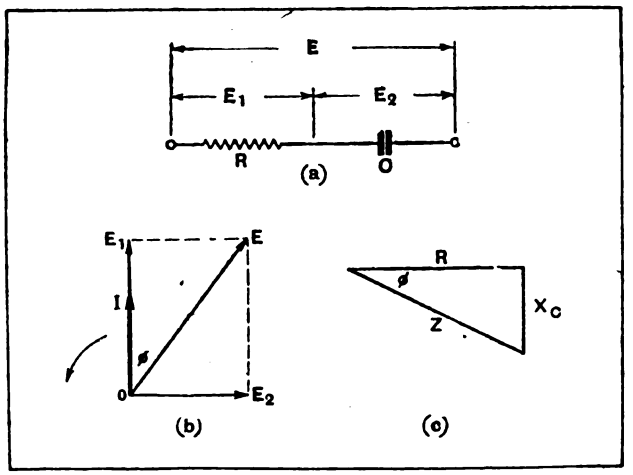

Fig. 1.—(a) Circuit with resistance and capacity in series. (b) Vectors showing the phase angles of the various voltages. (c) The impedance triangle for the circuit.

To illustrate the calculation of such a circuit as that of Fig. 1 (*a*) in practice, suppose that the resistance R has a value of 500 ohms and the condenser C a capacity of 10 microfarads and that we require to know the current taken when 100 volts (R.M.S. value) at 50 cycles per second is applied to the ends of the circuit. The reactance of the condenser

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Wireless Theory Simplified.—

is then $X=\frac{1}{2\pi fC}=\frac{10^6}{2\pi\times 50\times 10}=318$ ohms. The impedance Z is therefore $\sqrt{500^2+318^2}=583$ ohms, and so the current will be $I=\frac{E}{Z}=\frac{100}{583}=0.1713$ ampere. This current leads the voltage applied to the circuit by an angle whose cosine is $\frac{R}{Z}=\frac{500}{583}=0.857$, and this is the power factor of the circuit. Hence the power absorbed is $P=EI\cos\phi=100\times 0.1713\times 0.857=14.7$ watts; or by another method: $P=I^2R=0.1713^2\times 500=14.7$ watts.

Condenser and Resistance in Parallel.

In a circuit where the components are connected in parallel the same voltage is applied to each, and the best way to treat such a circuit if the applied voltage is known is to calculate the current through each branch separately, and find its phase relation to the voltage. The currents can then be added together in the proper manner, taking the phase differences into account. It is perhaps not out of place to remind the reader that currents or voltages must always be added by the parallelogram method when there are phase differences between them. Let us take as an example a circuit consisting of a 500-ohm resistance connected in parallel with a 10-microfarad condenser and assume that 100 volts at 50 cycles per second are applied to the ends of the circuit, as shown in Fig. 2 (*a*). We shall calculate the current and power taken by the circuit as a whole. Let I_1 be the current in the resistance branch, I_2 the current in the condenser branch and I the total current taken by the circuit. Then the current I_1 in the resistance will be $\frac{E}{R}=\frac{100}{500}=0.2$ ampere, and this will be in phase with the voltage. Similarly the current in the condenser branch will be $I_2=\frac{E}{X_c}$. But X_c for a 10-mfd. condenser at 50 cycles per second was found to be 318 ohms in the previous calculation: So the current in the condenser branch is $I_2=\frac{100}{318}=0.314$ ampere, and this leads the voltage by a quarter of a cycle.

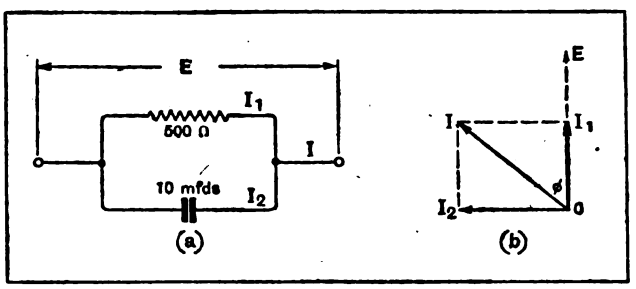

Fig. 2.—(a) Circuit with resistance and capacity in parallel. (b) Vectors giving the currents in the branches and the total current. $OI_1=0.2$ amp., $OI_2=0.314$ amp., $OI=0.372$ amp. when E = 100 volts at 50 cycles.

How to Use Vectors.

Knowing the value of each current and the phase angle of each with respect to the voltage, we could draw to scale a simple vector diagram as shown at (*b*) in Fig. 2. First draw the voltage vector OE of any convenient length, not necessarily to scale, and in any position. Since there is only one voltage value in a parallel circuit we take the voltage as the starting point. Now draw the current vector $OI_1=0.2$ ampere in line with OE and to a suitable scale of, say, 1 inch = 0.1 ampere so that OI_1 would be 2 inches long. Then draw OI_2 at right angles to OE to the *left*, because it is a current *leading* the voltage by 90°. Its length to the same scale will be 3.14 inches. On completing the rectangle, the length of the diagonal OI will give the value of the total current to the same scale. It leads the voltage by the angle ϕ which can be read off in the ordinary way with a protractor.

On the other hand the value of the current can be very easily calculated, since $OI=\sqrt{(OI_1)^2+(OI_2)^2}$. Hence $I=\sqrt{0.2^2+0.314^2}=0.372$ ampere. The impedance of the circuit is thus $Z=\frac{E}{I}=\frac{100}{0.372}=269$ ohms, and it should be noted that this is less than either the resistance or the reactance of the respective branches. From the diagram we see that the cosine of the angle of lead of the current is $\cos\phi=\frac{I_1}{I}=\frac{0.2}{0.372}=0.538$, being the power factor for the circuit as a whole. But the power factor is not given by $\frac{R}{Z}$ as it was for the series circuit. It happens to be $\frac{Z}{R}$ this time, but this must not be taken as a general rule for a parallel circuit.

There are two methods of calculating the power in this particular circuit: (a) By multiplying together the volts, amps. and power factor for the complete circuit in the usual manner, or (b) by calculating the power in each branch separately and adding the values together to get the aggregate. By the former method the power is E.I × (power factor) = 100 × 0.372 × 0.538 = 20 watts. Now in employing the second method we know that a condenser takes no power, and therefore that the whole of the power taken by the circuit is absorbed by the resistance, where the current was found to be 0.2 amp. Hence power = 0.2 × 100 = 20 watts as before.

Resistance, Inductance and Capacity.

Next we come to one of the most important circuits as far as wireless is concerned, namely, one in which all three constants, resistance, inductance and capacity are present. Under certain conditions, as every reader knows, such a circuit can be made to respond strongly to one particular frequency whilst giving but feeble response to other frequencies. We shall treat a series circuit first in a general way, and then lead on to the theory of the tuned circuit.

Suppose that a resistance of R ohms, an inductance L henrys, and a capacity C farads are all connected in series as shown in Fig. 3 (a), and that we desire to find what voltage E will be necessary to drive a current of I amperes through the circuit when the frequency is *f* cycles per second. The resistance R and inductance L might very well belong to a single coil, but for the sake of clearness we can imagine them separated.

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Wireless Theory Simplified.—

So R stands for the resistance of the whole circuit.

In the first place the same current I flows through each part of the circuit, and so we can write down the value of the voltage required by each portion separately, in terms of the current and the " constant " of that part. For instance, the voltage E_1 required to drive the current I through the resistance R is given by $E_1 = I.R.$ volts, and this is *in phase* with the current. In drawing the diagram of vectors the current vector OI is drawn first, in any position, and the voltage vector OE_1 for the resistance portion of the circuit is drawn in line with OI as these two are in phase. The complete vector diagram for the circuit is given in Fig. 3(b).

The reactance of the inductive portion of the circuit is $X_L = 2\pi fL$ ohms, and the voltage required to drive the current through it is $E_2 = IX_L$ volts. Since the current lags for an inductance it follows that this voltage E_2 must be ahead of the current by a quarter of a cycle. So in the vector diagram the vector OE_2 is drawn at right angles to OI to the *left* (see Fig. 3 (b)).

For the condenser the reactance is $X_C = \frac{1}{2\pi fC}$ ohms, and the voltage required to drive I amperes " through " it will be $E_3 = IX_C$, volts, and this *lags* behind the current by 90° because a condenser takes a leading current. Hence in the vector diagram the vector OE_3 is drawn to the right.

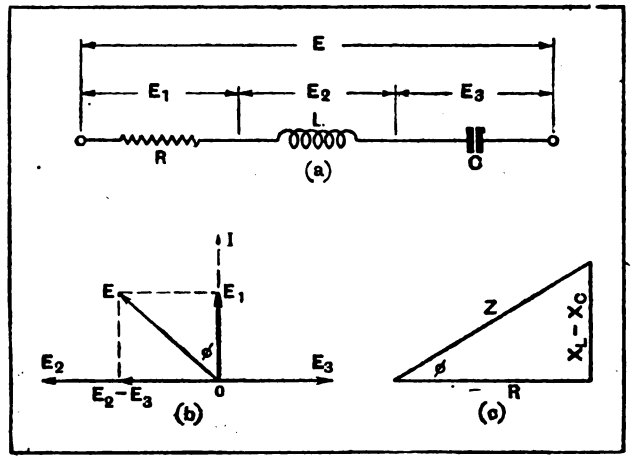

Fig. 3.—(a) Series circuit with resistance, inductance and capacity. (b) Vectors giving the phase angles of the various voltages. (c) Impedance triangle for the circuit.

Now the total voltage E required by the whole circuit will be equal to the sum of the separate voltages E_1, E_2 and E_3. But these three voltages are all at different phase angles, and in adding them the phase angles must be taken into account. However, the addition is a fairly simple one because the two voltages E_2 and E_3 are in direct opposition, one leading the current by 90° and the other lagging by 90°. Hence we can combine these two first, by the simple process of subtraction—the one has its maximum positive value at the same instant that the other has a negative maximum value. So the voltage required to drive the current through the inductance and capacity of the circuit, apart from the resistance, is $E_2 - E_3$ or $E_3 - E_2$ according to which of the voltages is the larger.

Power Factor for Series Circuit.

They might be equal, but for the present we shall assume that E_2 is larger than E_3, and therefore the voltage required by the inductance and capacity together will be $E_2 - E_3$, this voltage still being a quarter of a cycle out of step with respect to the current, as shown by the vector diagram of Fig. 3 (b). $E_2 - E_3$ may be called the total reactive voltage of the circuit.

Now we must add to this the voltage E_1 required by the resistance R. Since E_1 is in phase with I it is out of phase by 90° with respect to the reactive voltage $E_2 - E_3$. Hence the total voltage for the complete circuit is given by the diagonal vector OE, its value being $E = \sqrt{E_1^2 + (E_2 - E_3)^2}$ volts. But $E_1 = IR$, $E_2 = IX_L$ and $E_3 = IX_C$; and so $E = I\sqrt{R^2 + (X_L - X_C)^2}$ volts. From this we get the impedance of the complete circuit, namely, $Z = \frac{E}{I} = \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$ ohms.

This is the fundamental equation for a circuit in which all the constants are present in series. The quantity $\left(2\pi fL - \frac{1}{2\pi fC}\right)$ is the resultant reactance due to the combined effects of inductance and capacity in series, and if we denote it by X we arrive back at our original equation $Z = \sqrt{R^2 + X^2}$ ohms. The impedance triangle for the circuit is given in Fig. 3 (c), and by its aid we see that the power of cos ϕ is given by $\frac{R}{Z}$, also in agreement with our previous results. From this we can conclude that the power factor is $\frac{R}{Z}$ *for any series circuit.*

(To be continued.)

Catalogues Received.

J. J. Eastick and Sons, 118, Bunhill Row, London, E.C.—" Eelex Radio Bulletin " for October, 1929.

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Keith Prowse and Co., Ltd., 159, New Oxford Street, London, W.1.—Illustrated catalogue of proprietary portable and transportable sets now stocked.

o o o o

Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4.—Illustrated loose-leaf catalogue of radio components for 1930. Also descriptive folders dealing with the " Neutrosonic Short Wave Receiver," embodying the superheterodyne principle, and particulars of the Igranic " A.C.3," an all-electric broadcast receiver.

o o o o

Garnett, Whiteley and Co., Ltd., Lotus Works, Mill Lane, Liverpool.—Illustrated catalogue of " Lotus " components with special reference to their remote control system for mains operated receivers.

o o o o

Claude Lyons, Ltd., 76, Old Hall Street, Liverpool.—Descriptive booklet of the " Grassmann " moving coil speaker.

o o o o

Standard Wet Battery Co., 184, 188, Shaftesbury Avenue, London, W.C.2.—Illustrated folder dealing with tests that can be made with the Wates Volt-Amp. meter.

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CURRENT TOPICS

Events of the Week in Brief Review.

GWTC.

No known station hears this call-sign, but the letters are a useful memory jogger on shopping expeditions, meaning, of course, "Give Wireless This Christmas."

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THE WIRELESS TREASURE HUNT.

An invitation to participate in a search for "buried treasure" is extended to readers in our advertisement pages this week, prizes amounting in value to £20 being offered to successful entrants. The winners choose their own prizes.

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THIS WIRELESS AGAIN.

"Wireless in Court" was the description applied by several daily newspapers to recent experiments in Bow Street Police Court with a microphone and speech amplifier system.

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CHALLENGE TO DENMARK.

Sweden is now runner-up in the world's race for leadership in the percentage of wireless sets per head of population. According to a Stockholm correspondent, licensed listeners in Sweden on October 1st numbered 416,865, representing 68.3 to every 1,000 inhabitants. Only Denmark exceeds this proportion.

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'PHONE CALLS FROM THE ATLANTIC.

On Sunday last, December 8th, the Atlantic liner *Leviathan* opened a public ship-to-shore telephony service with equipment similar to that which will shortly be installed on the *Berengaria* and *Majestic*. The manufacturers are the Bell Telephone and the American Telephone and Telegraph companies.

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A TWO-METRE CLAIM.

Transmission tests with waves of three metres are referred to in the German amateur periodical, "CQ," which states that success on these high frequencies has been attained by Dr. Karl Stoye by means of a special arrangement of super-regeneration circuits. Transmitters and receivers functioning very efficiently on "the 3-3.40-metre waveband" are reported to be constructed with ordinary commercial apparatus, while a 2-metre wave is said to be attainable with the use of special valves.

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CHEER UP, ETHIOPIA.

Whereas the United States contains 9,640,348 wireless receiving sets, Ethiopia has only two, says the U.S. Department of Commerce. Britain is second in the list with nearly three million, followed by Germany and France. Japan is fifth with 550,000.

Licence fees are highest in Lithuania, where the listener must pay £2 12s. 5d. annually.

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IRISH BROADCASTING DELAYS.

Anxiety is being felt by listeners in the Irish Free State as a result of rumours that the project for a high-power broadcasting station is being shelved by the Government. The scheme aims at the establishment of a station in the centre of the Free State with sufficient power to cover the whole of the country. "Who will pay the piper?" is the question which the Government has to face.

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"ANARCHISTS OF THE ETHER."

Certain French amateurs who are distracted by oscillators and other "anarchists of the ether" are considering the initiation of a campaign similar to that of the Dutch Radio Union, writes our Paris correspondent. The sufferers in Holland are preparing for a systematised "day and night struggle" with all forms of radio disturbance, personal and otherwise. A permanent office has been established where complaints will be received and action taken under legal advice.

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A WIRELESS UTOPIA.

A Utopian dream has been realised by the U.S. Bureau of Standards in the acquisition of Pleasant Valley, Fairfax, Va., as an open-air radio laboratory. The site, covering 100 acres of abandoned pasture land, is flat and relatively free from trees, and is believed to be almost ideal for its purpose, viz., the study of fading.

Ordinary overhead aerials are to be dispensed with, the antenna system being limited to a vertical rod about 55 feet high and a number of direction-finding loops. To obviate "man-made-static," the power line for replenishing batteries from the mains can be disconected.

The Bureau of Standards is retaining its field laboratory at Kensington, Ind, for investigation into radio echo phenomena.

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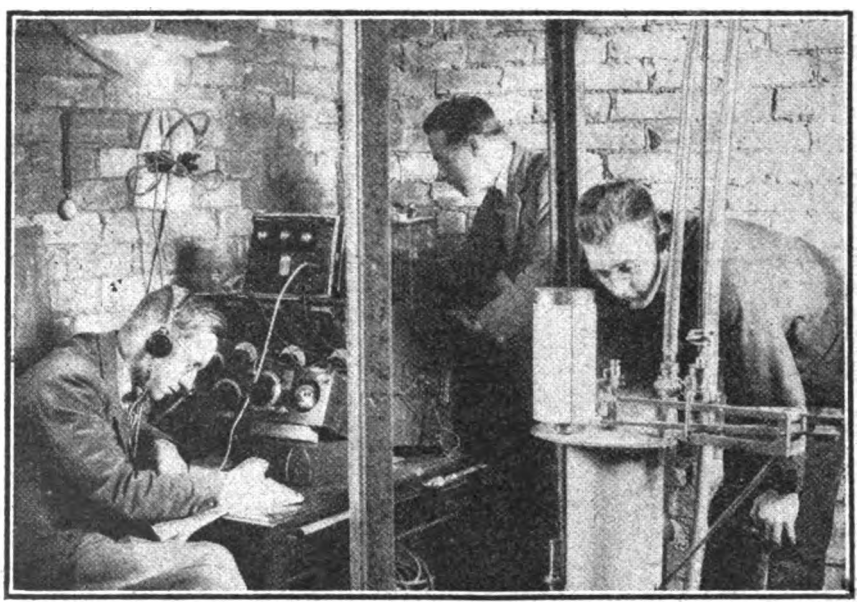
PARIS CRITIC OF *THE WIRELESS WORLD*.

In our esteemed French contemporary, *La Parole Libre en T.S.F.*, M. René Sudre makes a spirited reply to the remarks of *The Wireless World* regard-



AN IMPROMPTU WIRELESS STATION. Temporary gear in use at Howden Aerodrome, Yorks, for the collection of weather data in preparation for the flight of the airship R.100 to the mooring mast at Cardington.

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ing the Paris Radio Salon and the inextinguishable popularity of the superheterodyne.

"Instead of attributing this to the French desire for good broadcasting," says M. Sudre, "the critic of *The Wireless World* concluded that the patent question is the true cause of the reign of the superheterodyne. . . . On the day that we have a good radio organisation it is possible that we shall go to London for the fashion of our receivers as well as for the cut of our lounge suits. But it is also possible that we shall remain faithful to the frequency changer, reduced to its five, or even four, valves. It is a truly French system which combines elegance of conception with perfection of result."

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"SMALL ADS." AT CHRISTMAS.

Christmas causes delightful havoc to our ordinary printing arrangements, and it is therefore necessary to close for press earlier than usual with our issues of December 25th and January 1st. Miscellaneous advertisements for inclusion in the former can be accepted up to the first post on Wednesday, December 18th; those for January 1st should be in our hands not later than first post on Tuesday, December 24th.

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WIRELESS ON NON-STOP FLIGHT.

In its attempt to beat the world's non-stop record for distance by flying from Britain to South Africa, the Fairey Napier Lion monoplane will carry a small wireless transmitter for sending out messages at hourly intervals indicating its position. Wireless is considered more necessary on this flight than on the Fairey monoplane's non-stop trip to India, which covered a route served by aerodromes at regular intervals.

The transmitter, with the call-sign GEZAA, works on 33.71 metres. Reception reports should be sent to the Signals Branch, Air Ministry, Kingsway. The flight is scheduled to start on any date from December 18th onwards.

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BELGIAN BROADCASTING.

The new Belgian Wireless Bill has passed successfully through the Chamber of Representatives and is now awaiting the approval of the Senate. The Bill gives the postal administration complete control of broadcasting, which will be directed by a National Wireless Institute, operating two high-power stations broadcasting in French and Flemish respectively. The council of control will include a number of independent personages, including four technical authorities, and will be presided over by the Belgian Postmaster-General.

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GRAMOPHONE TONE CONTROL.

Dr. N. W. McLachlan will give a lecture-demonstration on "Tone Control for Electric Gramophones" at a meeting of the Incorporated Radio Society of Great Britain on Friday next, December 13th, at 6 p.m., at the Institution of Electrical Engineers.

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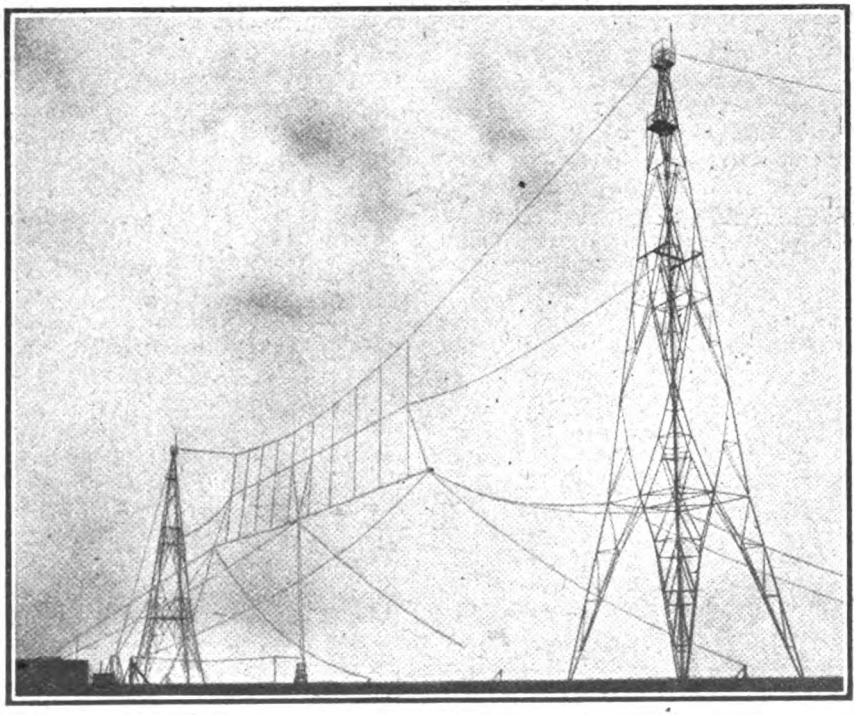
STANDARD BATTERY COMPANY.

We hear that the official title of the Standard Wet Battery Company has been changed to "The Standard Battery Company."



HOLLAND'S NEW SHORT-WAVE STATION. The aerial system of PHI at Huizen. The equipment is described in the following pages.

CLUB NEWS.

Invitation to Birmingham Enthusiasts.

A review of the past year's activities of Slade Radio (Birmingham), was given by the chairman, Dr. C. H. Harcourt, at the second annual general meeting held recently. The Society has apparently overcome the difficulties which are often encountered towards the end of the second year, and is entering its third year with confidence.

An appeal is now made for more members, and anyone who is interested in wireless is invited to get in touch with the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham, who will gladly forward details of the Society. An open invitation is also given to attend one of the Society's meetings any Thursday at 8 o'clock at the Parochial Hall, Broomfield Road, Slade Road, Erdington, Birmingham.

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An All-electric Receiver.

Mr. A. J. Hall, G2NU, of Philips Lamps, Ltd., has been engaged for some considerable time on research work on all-electric receivers, so his lecture and demonstration before the Muswell Hill and District Radio Society on November 27th were of more than usual interest. To convert the local D.C. supply to A.C. in order to run the A.C. demonstration receiver a special A.C. generator, driven off the D.C. mains, was used, and proved quite satisfactory. The lecturer pointed out the numerous advantages of all-mains sets over battery-driven ones, and gave a demonstration of one of his firm's well-known receivers, upon which a large number of Continental broadcast stations was logged at very good strength, despite the poor antenna system available.

Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road, N.10.

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"Talkie" Secrets Disclosed.

Mr. Hawker, of the Western Electric Company, visited the Wembley Wireless Society recently and gave a lucid description of the method of production and reproduction of "talkie" films.

The lecturer, who has been actively engaged in the preparation of some recent famous talking pictures, let the members of his audience into many secrets of the "talkie" studio.

It was stated that "talkie" films were introduced many years ago but that owing to the reluctance on the part of the film producers the invention was not seriously taken up until quite recently.

At the Society's next meeting on December 13th Messrs. Hart and Perry will continue their "Practical Hints and Tips" demonstration, dealing with the best way to use a soldering iron.

Hon. Secretary, Mr. H. E. Comben, B.Sc., 24, Park Lane, Wembley.

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Varied Fare.

A vigorous debate on the respective merits of the moving-coil and balanced armature types of loud speaker was one of the recent features of the Golders Green and Hendon Radio Society's programme. Mr. Bremner, B.Sc., championed the former, while Mr. Maurice Child upheld the latter.

Programme problems were discussed by a representative of the B.B.C. at a recent meeting, and a lecture of absorbing interest was that given by Mr. H. T. Barton Chapple, B.Sc., on the subject of television.

The Society's future fixtures include lectures on such varied topics as "talkie" films, colour photography, all-mains receivers, and metal rectifiers. The next club dance will be held on December 27th.

Hon. Secretary, Lt.-Col. H. A. Scarlett, D.S.O., 60, Pattison Road, N.W.2.

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Query Night at Tottenham.

Knotty points of theory in the working of certain portions of a typical radio receiver were explained by Mr. Bodemeaid at the last meeting of the Tottenham Wireless Society. The lecturer had previously obtained from members particulars of points which they had found rather difficult of explanation, and these were worked through one by one. Among the points dealt with were the explanation of the working of a detector valve, the nature of the current before and after detection, and the reason why the rectified current can operate transformers and pass through condensers, etc. The lively discussion which was maintained during the whole of the evening indicated the great interest taken by the members in this type of meeting.

Hon. Secretary, Mr. W. Bodemeaid, 10, Bruce Grove, N.17.

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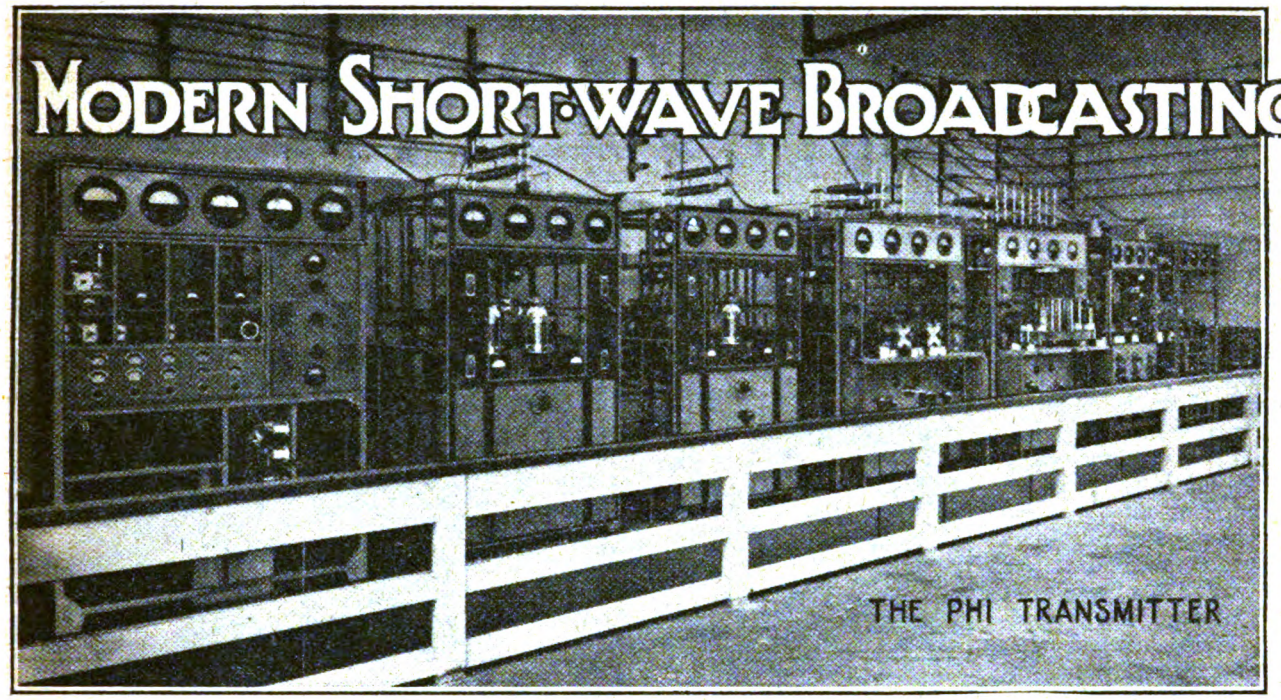
MODERN SHORT-WAVE BROADCASTING



The New Station at Huizen.

By A. J. HALL (*of Philips Radio*).

THE experience gained by the engineers who designed the Philips experimental short-wave station PCJ, has been very liberally drawn upon in the development of the new Dutch short-wave transmitter PHI, located at Huizen.

Even accustomed, as we are, to the very rapid developments in the technique of radio transmission and reception, it can still seem strange that the energy passed to the aerial of this gigantic transmitter is effectively controlled by a piece of quartz comparable in size with a halfpenny!

A glance at the illustration on this page, showing the seven frame-type panels, will indicate the progressive increase in the power handled in succeeding stages of the transmitter.

Commencing with the first panel (stage No. 1)—on the extreme left—the upper portion of this houses the "crystal oscillator." A piezo-electric crystal, ground to oscillate at a frequency of 2,222 kilocycles, is used in conjunction with a 4-volt receiving valve. The purpose of this stage is merely to furnish an output at a dead-constant frequency, to ensure strict adherence of the transmitter to its assigned wavelength. The feeble output of this piezo-electric oscillator is fed to the compartment immediately beneath, which contains two small transmitting valves of 10-watt rating, arranged in push-pull. The constant frequency signal is thus magnified to a suitable value for passing to the next stage.

In the third and fourth positions of this same panel, two operations are performed, viz., frequency doubling and amplifying. Whilst the input to the third position is at a frequency of 2,222 kc., the output circuit is tuned to double this frequency, and a suitably amplified output at 4,444 kc. is available from position number four.

The next operation again doubles the frequency, at the same time amplifying the signal at such frequency, giving a resultant of 8,888 kc., from which it will be seen that a wavelength of 33.75 metres has been reached (positions Nos. 5 and 6). The anode feed to the initial stages, thus far, is at 400 volts. Special precautions are taken with respect to electrical screening, for such a step is found necessary if feed-back trouble in the crystal oscillator stage (the effect of which is promptly to shatter the small quartz crystal) is to be avoided. In the sixth position valves fed at 2,000 volts are used.

The second panel unit incorporates two valves of 1½-kilowatt rating, again connected in push-pull formation, making position No. 7. It is in this stage that the final frequency doubling operation is carried out, resulting in the working frequency of 17,778 kilocycles, corresponding to a 16.88-metre wavelength being produced.

Position No. 8—shown in the photograph as the third panel—performs an amplifying operation in which 1½-kilowatt valves are again used, this time, however, fed at an anode voltage of 4,000. At this juncture, the water-cooled type of valve can be more conveniently used, and succeeding stages, therefore, embody valves of this type, which are capable of taking up to 12,000 volts anode tension.

The ninth operation is again amplifying, the stage comprising two water-cooled valves of 10-kilowatt

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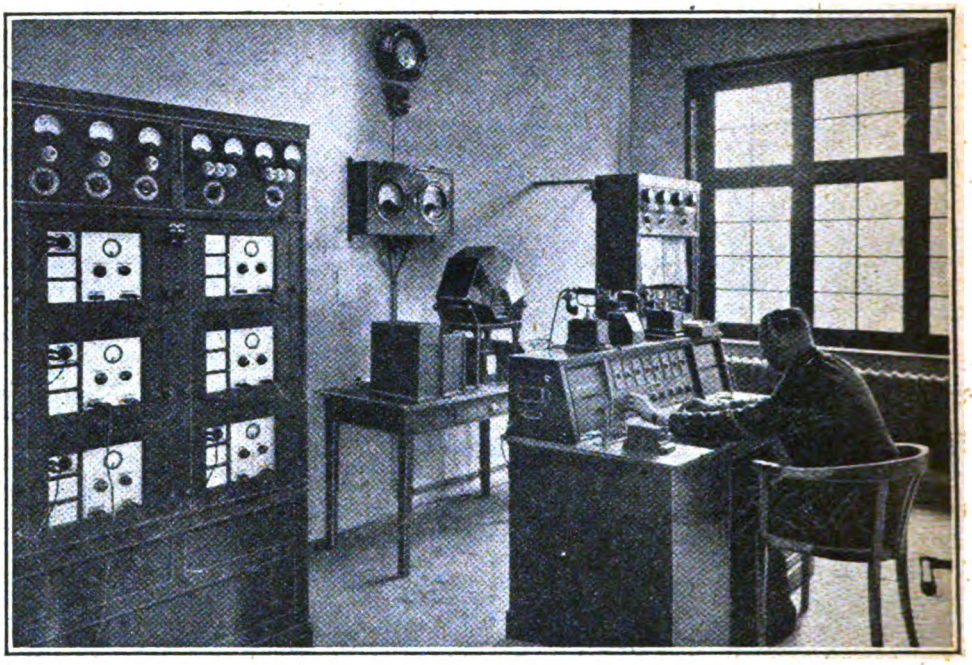
Modern Short-wave Broadcasting.—

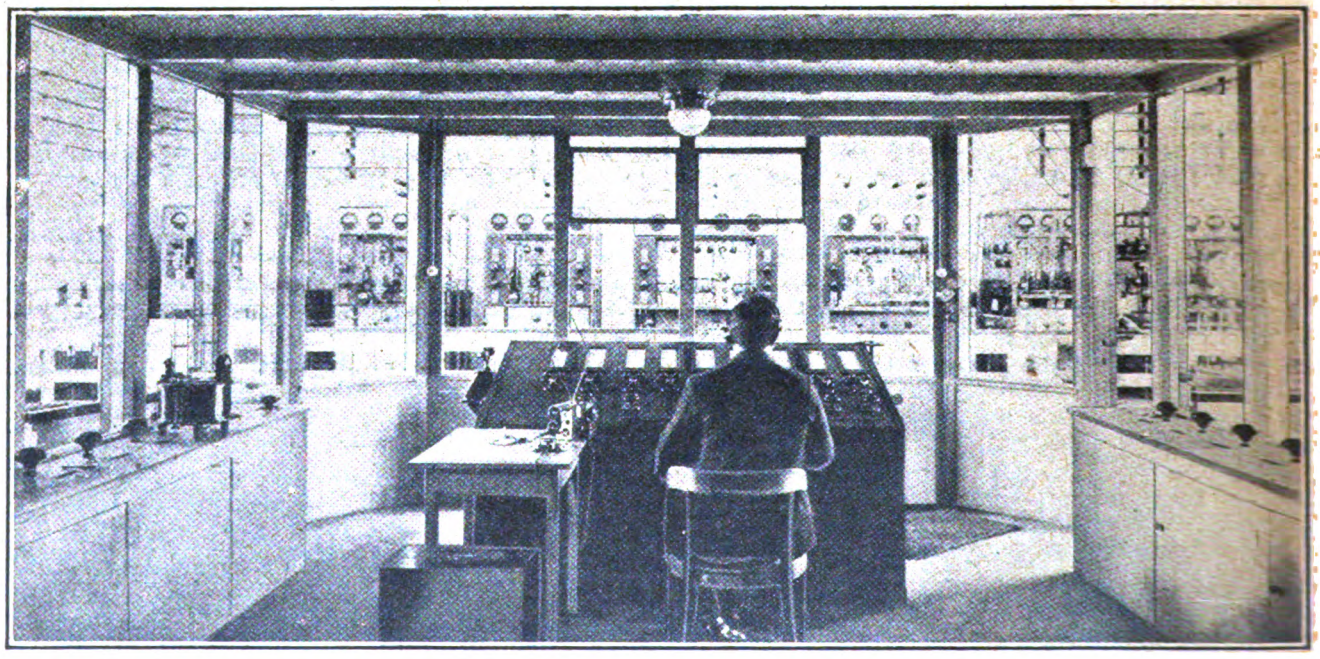


The studio control room at Huizen. A special land line connects the station with Amsterdam, enabling the celebrated concerts in that city to be relayed.

rating. The fourth panel in the illustration depicts this stage. In the tenth operation the power dealt with is no less than forty kilowatts, handled by two valves. Even this does not represent the maximum that can be dealt with, for an anode feed current as large as six amperes at an applied voltage of 10,000 has actually been recorded.

It may here be said that such a comparatively large power input is really an accomplishment in the present stage of ultra-high frequency technique, for the operation of valves at such powers, when handling ultra-high frequencies, presents difficulties not encountered in the generation of frequencies corresponding to the usual broadcast wavelengths. It is known that when dealing with ultra-high frequencies, capacitive currents—which can attain surprisingly large values—flow in certain conductors, and there are necessary precautions to be taken to minimise the effects of such parasitic currents. The signal energy has now reached the stage at which modulation takes place, and in the anode feed circuit of the valves incorporated in this fifth panel unit the necessary modulating transformers are installed.

The modulating unit proper is embodied in the sixth panel, and is equipped with two modulating valves of 15 kw. rating for each of the three transformers. The seventh panel, equipped with four amplifying valves,



From the vantage point of the engineer's control desk, shown above, every portion of the transmitter is under constant observation. The motor generators in the engine room are operated by a remote control device.

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is the final stage, the output being fed to the aerial. The overall power input is no less than 130 kilowatts, and naturally the supply of this amount of energy at several different voltages presents no small problem.

Reference to the photograph of the high-power rectifier unit will show how the supply is obtained. The main rectifying bank, shown in the picture, furnishes an output of up to 12,000 volts for the higher-powered stages of the equipment, and it will be observed that the water-cooled type of rectifying valve is used.

The medium-power rectifying bank using air-cooled valves operates on an 8,000 volts polyphase supply, whilst the water-cooled bank rectifies a six-phase supply at 14,000 volts.

The smoothing problem is very much simplified by the use of six-phase alternating current.

A comparatively small value of capacity shunted on the output of such a rectifier will yield an output having no trace of ripple, a very necessary feature in a telephony transmitter.

The accompanying photograph shows the Duty Engineer's control position. Necessary indicating meters are conveniently placed, and the operation of the entire transmitter, from the crystal stage to the aerial input, is thus under constant surveillance.

A check on the outgoing signal is maintained by means of the monitor, with its single-turn loop aerial, to be seen on the immediate left of the Duty Engineer. The engine-room is also linked up by remote control with the Duty Engineer's desk.

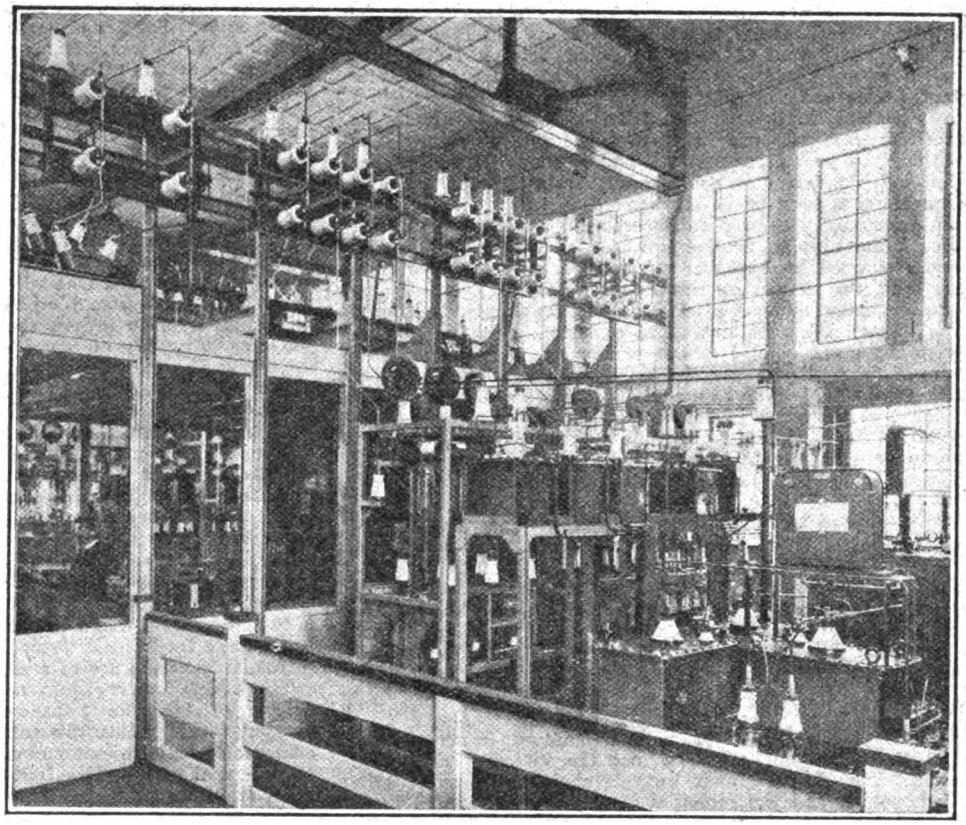
The filament lighting load, in itself, represents quite a formidable power load, very close regulation of which is essential. Immediately adjacent to the guard rails, in front of the seven panels, can be seen the filament controls which permit adjustments to be made during operation of the transmitter, without necessitating a near approach to any of the apparatus under voltage. The scales of the meters are so disposed as to be visible at a distance of several feet.

The studio microphone is connected to the "A" amplifier rack in the adjoining main control room, the panel incorporating no fewer than six amplifiers equipped with necessary gain controls.

A special land-line connects the control-room with Amsterdam, thus permitting the well-known concerts from that city to be relayed to the far-distant audience of the station.

The aerial used is of the Beam type, and is supported between two masts about 200ft. in height. The orientation of the aerial is such that the strongest signal is placed in territories on a line joining Huizen and the Dutch East Indies.

The choice of wavelengths is governed by several considerations, an important one being the mean noise level from atmospheric disturbances in the location in which the reception is desired. In certain parts of the world there are periods during the year when radio reception on any wave greater in length than about 40 metres—sometimes less—is impossible, due to the severe atmospheric disturbances. With the choice of a wavelength as low as about 17 metres, the atmospheric bugbear will be very much less in evidence, and "all-the-year-round reception" will, therefore, become almost a certainty.



The high-power rectifying plant at Huizen. The main rectifying bank, seen in the picture, gives an output up to 12,000 volts. Water-cooled valves are used in this stage.

At the present time, the Huizen short-wave transmitter is not operating to standard programme times, but it is expected that the station will go into scheduled operation in the near future.

Reports from many places speak with enthusiasm of the excellent reception and outstanding quality of the transmissions from this new station, which bids fair to establish a name even surpassing that of PCJ.

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CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

RECEPTION OF CONTINENTAL STATIONS.

Sir,—As I, too, have been a wireless enthusiast since the early days of broadcasting, and take a keen interest in long-distance reception, I was very interested in the letter from Mr. A. W. Scott in your issue of November 27th.

I cannot, however, agree with his assertion that "the 'enjoyment' of foreign transmissions is an absolute myth" and his description of reception from foreign stations as "awful noises—transmission plus mush, atmospherics, heterodynes, fading and morse."

All stations (irrespective of whether they happen to be British or foreign!) are liable to the forms of interference mentioned by your correspondent, and whether the interference is seriously disturbing or not depends very largely on the ratio of interference to strength of received signals.

On a reasonably efficient set incorporating a screen-grid H.F. stage, I am able to receive upwards of twenty Continental stations at good loud-speaker strength on most evenings from dusk onwards. A smaller set (detector and L.F.) enables me to get a similar number of stations on headphones. I do not claim that all these stations afford consistently reliable results, but on any given night I can invariably select, from this wide choice of programmes, several Continental transmissions which, apart from slight fading, are receivable with a volume and quality that compares favourably with reception from Daventry 5GB. It is manifestly absurd to describe these foreign transmissions as "awful noises" merely because they happen to originate on the other side of the Channel or the North Sea!

As the regular reception of foreign wireless programmes by a large number of listeners is calculated, directly and indirectly, to help in bringing about a better understanding between people of different nationalities, it seems rather a pity to discourage it in any way, but of course one appreciates that the B.B.C. cannot be expected to hamper the development of our own broadcasting service on this account. W. OLIVER.

London, S.W.18.

Sir,—The letter over A. W. Scott's signature, in my opinion, voices the feeling of many, if not the majority of licence holders. The B.B.C.'s main duty is obviously to supply the British public, and the reception of foreign programmes is no concern of theirs. I agree that the latter would be worth listening to if they could be received as transmitted, but with the multiplicity of foreign stations this is now a hopeless proposition. Years ago much pleasure could be derived from them, but now it is definitely better to rely on our own programmes, which on the whole are satisfactory.

Mr. Baggs in his letter voices a real grievance in his complaint of London programmes being relayed. My own set, a "Wireless World" screened-grid five, gives excellent reception of 2LO, 5XX, 5GB, and Manchester, but as a general rule this gives only two programmes from four stations, with the inevitable military band from one.

I do hope when the second programme from 2LO is radiated it will give an alternative programme, and that the Northern Regional Station will give a third choice.

This, I understood, was the whole idea underlying the Regional Scheme.

It is up to the ordinary listener to make himself or herself heard on this point, but the apathy of these people is such that it lulls the B.B.C. into a sense of complacency which is definitely to the detriment of all concerned. L. N. GROVER.

Eastwood, Notts.

B.B.C. TRANSMISSIONS.

Sir,—The letter appearing in your issue of November 13th over the pseudonym of "Fair Play" contains a number of errors and misrepresentations of which I ought, perhaps, to take notice.

In my letter in your October 23rd issue I did not imply that *all* distortion occurs in B.B.C. land lines *and/or transmitters.* I implied, on the contrary, that the defects of any one transmitter were not sufficient to impair the satisfactory quality of direct transmission. Sources of error in my set would not prejudice my point, which was that my apparatus, such as it is, gave me satisfactory results with direct but not with other transmissions. Defects in reception would affect all transmissions alike.

A perfect or elaborate set is not needed to make obvious the deficiencies of land-line and wireless-link transmissions. If "Fair Play" can get near enough to a suitable transmitter, a crystal set and a pair of telephones ought to enable him to differentiate for himself between the various transmissions. The problem he sets for my solution, the old problem of obtaining both quality and selectivity, is therefore in this particular connection quite irrelevant. The lines, however, on which it may be satisfactorily solved he will find indicated for him in recent pages of *The Wireless World.*

It is an error to suggest that the human ear is not the final judge as to quality of reproduction. The sole aim of wireless is to give the normal ear a sufficiently approximate duplicate at one end of the process of what it would hear were it at the other. Scientific tests and measurements serve their purpose. They reveal and localise defects and indicate the direction and degree in which improvement is required. They show also that the ear does not demand perfection but will, within limits, tolerate defects. This tolerance, however, far from invalidating an adverse judgment by the ear, only confirms it and puts it beyond question.

It is quite improbable that the B.B.C. would claim that *all* their radiations were as good as *any* set reproducing them. (I use here "Fair Play's" imperfect method of expression.) It is to be observed, too, that "Fair Play" finds it convenient to forget that the B.B.C. themselves, in one of their methods of transmission, make use of a receiving set.

The Chief-Engineer does not require proof of the serious defects of land-line transmissions, nor even to have them brought to his notice. In regard to such defects, he has the evidence of his own ears and also, I believe, a certain quantity of technical data. The following passage is taken from a letter from Mr. A. L. Barham published in *The Wireless World* of January 19th, 1927.

> "By great courtesy of B.B.C. engineers I spent a very fascinating afternoon at Savoy Hill a week or so ago and was shown some actual curves of frequencies passed by various land lines lent by the G.P.O. to B.B.C. Most of them were most irregular in the way the sonic frequencies were passed, generally looking more like malarial temperature charts than any instrument response. One comparatively short line had a complete cut-off above 3,000 cycles! As different lines are used at different times the practical difficulties in compensating can be imagined."

Any improvement in land-lines and land-line technique during the past three years has not sufficed to effect any noticeable amelioration in the quality of land-line transmission.

The Chief Engineer is unable completely to rectify land-line errors. He gives us at present the best he is capable of in the way of land-line transmission and he can do no more.

There is no reason why we should not all have, at least occasionally—I mean, of course, in the provinces—concerts of the same merit as those from Queen's Hall by direct transmission from our local stations.

I admitted nowhere in my letter that Daventry 5XX was available as an alternative to Newcastle. Daventry 5XX can be easily heard here, but its reception is too liable to interference by various forms of "mush" for it to be accepted as giving an adequate alternative service.

Newcastle-on-Tyne. K. McCORMACK.

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READERS' PROBLEMS

"THE WIRELESS WORLD" SUPPLIES A FREE SERVICE OF TECHNICAL INFORMATION

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Tracing Power Circuit Interference.

I am occasionally troubled by cracklings and other intermittent noises, which I believe come from the electric power wiring in my neighbourhood, or perhaps from my own house wiring. Can you suggest a simple test which will enable me to determine whether this interference is due to the latter wiring, or to an external source? S. T. A.

This test should be easy to carry out. All you have to do is, at a time when the interference is particularly noticeable, to take out your main switch, which will certainly be of the double-pole type. If, on doing this, there is no appreciable change in the character of the interference, you may justifiably assume that it is entirely from an outside source.

It will be hardly necessary to add that this test should be repeated several times, preferably with the help of an assistant if the set is at some considerable distance from the main switch.

oooo

Screening S.G. Valves.

I have some well-made copper screening boxes, measuring 8in. x 8in. x 7in. high, and should like, if possible, to use them in the construction of a receiver on the general lines of the "New Kilo-Mag Four." Would there be any harm done if the H.F. valves were mounted vertically in the first and second compartments? W. S. W.

We would strongly dissuade you from adopting this course, unless you are willing to be satisfied with an overall magnification much less than the maximum attainable. If the design of most modern multi-stage H.F. amplifiers is carefully considered, it will be found that it is usual practice to take some pains both to screen individual grid and plate circuits and to isolate the valves themselves from stray fields.

We suggest that you should either mount the valves on "outriggers" behind the screening boxes, as in the original "Kilo-Mag Four," or perhaps better, if the overall width of the receiver is not a matter of great importance, that the boxes should be mounted on the baseboard with a space of some 2in. separating them, thus allowing the valves to be mounted between the screening compartments. This method was exemplified in the "Foreign Listeners' Four."

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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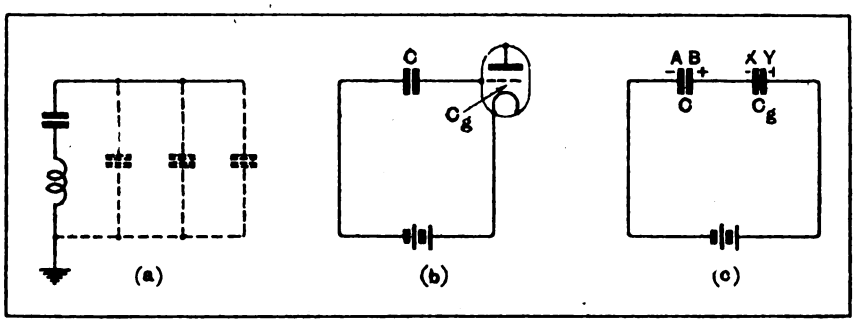

Fig. 1.—The interposing of a condenser in an aerial (a) or grid (b) lead does not constitute a break in the circuit as the condenser is merely connected in series with an existing capacity.

Electrons and Condensers.

With reference to your series of articles, "Wireless Theory Simplified," I have found it quite easy to understand how an electron flow through a condenser is brought about, but cannot quite grasp how this takes place in such practical cases as that of an aerial with a series condenser or of a valve with a condenser in series with its grid. In neither case does there appear to be electrical continuity between the two plates of the condenser.

A few words of explanation would be greatly appreciated. W. T. T.

As you suggest, a condenser cannot be charged unless there is an external circuit, but in both cases instanced this condition obtains, although the circuit is actually completed through another condenser in series with the first.

In the case of the open aerial there is actually a considerable capacity between the aerial wire and earth; the whole system may be represented as Fig 1 (*a*), where this external capacity is shown by dotted lines.

A similar explanation applies to the series grid condenser (C in Fig 1 (*b*)). It must be remembered that there is a small but definite capacity between grid and filament (denoted by C_g), and that this constitutes a second condenser through which the circuit is completed in the manner shown in Fig. 1 (*c*).

When the plate A of condenser C is given a negative charge, it apparently attracts a positive charge to, but actually drives negative electrons away from, plate B. These are sent across to plate X of condenser C_g, and constitute the counterpart there of those electrons which have been drawn off from plate Y by the battery. For further explanation of the subject of condensers in series we would refer you to our issue of November 27th.

Still referring to Fig. 1 (*c*), it should be realised that the voltage applied by the battery is divided between the condensers in the inverse ratio of their capacities, and where the capacity of one of the condensers is very small compared with the other, practically the whole of the voltage is set up across the smaller one. If C has a value of 0.0003 mfd. (or 300 mmfd.) and C_g a value of 10 mmfd., the voltage will be divided in the ratio of 300 to 10 between the condensers. Thus if the E.M.F. of the battery is 10 volts, the voltage across C will be $\frac{10}{310} \times 10 = 0.322$, and that across C_g will be $\frac{300}{310} \times 10 = 9.678$.

Plates B and X are at the same potential, since they are joined: the signs indicate distribution of electrons only.

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The "Selectivity-Quality" Problem.

In Fig. 1 of the above article in your issue of November 27th, a fixed resistance of 60,000 ohms is shown as being connected between one side of R_1 and the filament of the detector valve. It seems to act more or less as a short-circuit across the H.T. supply leads. Will you please explain its purpose? S. J. E.

This resistance forms one arm of a potentiometer, of which R_1 is the variable element. The voltage applied to the detector anode will be determined largelv by the relationship between the values of these two resistances.

In the receiver under discussion there is a very considerable difference between the main H.T. input voltage and that suitable for the detector, and in these circumstances it is desirable to ensure a sensibly constant voltage feed by fitting a potentiometer device instead of a simple series resistance.

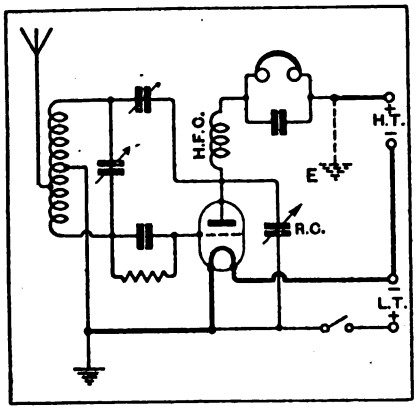

Fig. 2.—When the positive L.T. lead is earth connected there is a possible risk of burning out the valve filament. Short-circuit path is shown in heavy lines.

Still Another Way of Burning Out Valves.

Some little time ago I made up a single-valve detector set with throttle-controlled reaction on the general lines of a circuit shown in your journal, but with one or two minor modifications. As the set was built into a small metal cabinet the positive terminal of the L.T. battery was "earthed" to the case, in order that an existing on-off switch (of which one terminal was in metallic connection with the fixing bush) could be used. Negative terminals of high- and low-tension batteries were connected together, as is always recommended.

In view of the fact that these precautions were taken, I had hoped that the set would be as "safe" as could be expected, but I have actually burnt out the valve on two separate occasions by allowing the high-tension positive lead accidentally to make a momentary contact with the metal container.

Is this particular circuit arrangement especially prone to this trouble, or have I made a mistake in "earthing" the positive side of the low-tension battery? L. H.

Much space has been devoted in this journal to the subject of "safety" valve filament connections; your own arrangement most definitely does *not* come under this category.

We expect that your circuit is that shown in Fig. 2. We have added an earth connection (marked E), which represents what takes place when the H.T. positive lead makes accidental contact with the metal work. If you consider the diagram carefully you will see that this connection provides a "through" circuit, *via* the valve filament, across the H.T. battery, provided that the on-off switch is open.

The throttle control reaction circuit need introduce no more risk of damage to valves than any other, provided that proper precautions are taken in arranging the filament wiring, etc.

oooo

Parallel Feed L.F. Amplifier

In a set on the lines of the 1930 Everyman Four, but with a power valve in the first L.F. position, would it not be preferable to replace the anode resistance by a high-inductance choke? I ask this because it seems that when using a low-impedance valve taking a considerable anode current, there would be an excessive loss of voltage in the resistance. C. B. N.

In a case of this sort we think it would be a mistake to use a choke in place of a resistance, as by doing so there is a risk of upsetting the characteristics of the transformer. In any case, it must be realised both that the inductance of the choke would be considerably reduced were a heavy current to be passed through it, and that there is a tendency for the grid volts/anode current curve of a valve to straighten out when a resistance is connected in its anode circuit. Assuming a fairly conventional arrangement, with reasonable H.T. voltage, we think you need have no fear that the first L.F. stage, if arranged as in the 1930 Everyman Four, will deal with a sufficient input.

oooo

Filter Output as Stabiliser.

I have just replaced a choke filter arrangement by an output transformer, with the result that the set, which was previously quite stable, is now totally unmanageable, and produces violent L.F. oscillation. Is this a usual effect, and, if so, will you please suggest a cure? L. B. G.

An output filter, of the type in which one side of the loud speaker is earthed, acts as a decoupling device by virtue of the fact that speech frequency currents are largely diverted from the common source of H.T. current by the anode choke, which almost invariably has a much higher impedance—at any rate to currents corresponding to the upper range of audible frequencies—than the alternative path.

The fact that you have noticed this effect would point to the need for inserting decoupling resistances in the anode circuits of detector and 1st stage L.F. valves. This should provide a cure, and enable you to use your output transformer with satisfactory results, but if stability is still lacking please send us a circuit diagram of your receiver, with details of the source of H.T. current supply.

oooo

Considerations in Design.

In the design of the Record III, an attempt was avowedly made to attain the maximum possible amplification consistent with the retention of side-bands: I am puzzled as to why a 4in. diameter litz coil, similar to the H.F. transformer secondary, was not used for the H.F. grid coil. Is it not a fact that a high-inductance coil of low H.F. resistance could with advantage be used in this position, providing still greater amplification and less sideband cutting? W. M. T.

Tuned circuits having a large inductance and a small capacity contribute comparatively little to the overall selectivity of a receiver, and on these grounds alone it would probably be injudicious to include a second one of this type in the receiver. Further, a high-inductance coil cannot usefully be employ l unless all possible steps are taken to reduce incidental capacity across it, and consequently its use would necessitate "decapping" of the H.F. valve as well as of the detector, which was considered to be undesirable.

oooo

FOREIGN BROADCAST GUIDE.

EIFFEL TOWER

(Paris, France).

Geographical Position: 48° 51′ 30″ N. 2° 17′ 43″ E.

Approximate air line from London: 214 miles.

Wavelength: 1,444 m. Frequency: 205.76 k.c. Power: 12 kW.

Time: Greenwich Mean Time.

Relays main transmissions from the Ecole Supérieure (PTT), Paris.

Standard Daily Transmissions.

8 a.m. news and time (from PTT, Paris); 12.15—13.30 concert interspersed with short news bulletins; 13.30—15.40 news, talks, etc.; 17.45 concert; 19.20 (Sun. 19.50) concert followed by relay of PTT Paris.

Male announcer. Call (when own transmission): *Ici le Poste National de la Tour Eiffel* (repeated). (When relaying PTT Paris): *Ici les emissions de T.S.F. du Reseau Français de Radio-diffusion des stations de l'Ecole Supérieure et de la Tour Eiffel.*

Opening signal: Seconds counted in the French language.

Time signal (when relaying PTT Paris): Carillon de Fontenay (clock with chimes).

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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THE MARCONI ROYALTY COMPROMISE.

AGREEMENT appears to have at last been reached between the Marconi Company and those manufacturers who were licensees under the Marconi patents. It will be remembered that negotiations for a modified licence agreement began as soon as the appeal of the Marconi Company had succeeded against an order by the Comptroller of the Patent Office under which the amount of royalty payable by licensees to the Marconi Company was reduced from 12s. 6d. per valve stage to 5s. for the first valve and 2s. 6d. on succeeding valves.

The effect of the success of the Marconi appeal against this order was to reinstate the position of the Marconi Company; the judgment deciding that the amount of the royalty could only be reduced by agreement with the Marconi Company, who were entitled to grant or refuse licences under their patents practically on what terms they pleased.

At the time that this judgment was given many months of arrears in royalties on the basis of 12s. 6d. per stage had accrued to the Marconi Company's credit, but so confident were the licensees that the new rate of 5s. and 2s. 6d. would apply that in many instances only this latter amount was taken into account in deciding upon the price at which receivers would be sold.

Had the full royalty of 12s. 6d. been demanded retrospectively by the Marconi Company, it is probable that a number of firms would have been unable to pay, and consequently it seemed highly desirable that some new agreement should be formed which would amount to a compromise to get over the difficulty.

A compromise has now been arrived at by which the royalty is agreed upon as 5s. per valve stage, irrespective of the number of stages, whether or not they utilise patents subject of the licence, with a further 5s. in the case of sets which include a battery eliminator employing any patent. Licensees must accept the agreement for the full period of the licence, which is from August 28th, 1929, to August 28th, 1933.

The licence is granted in respect of past and future patents of the Marconi Company and the Gramophone Company (which recently entered into an agreement to acquire the Marconi Company's interest in broadcast receiving apparatus).

Many of the more important patents held by the Marconi Company at the time of the old agreement have since expired, or will run out well within the new period to August, 1933, so that the Marconi Company benefits very largely by extending the period over which it is assured a substantial revenue from its patents, but the rate of 12s. 6d. over the period during which the question of royalties has been in dispute could legally have been insisted upon by the Marconi Company, so that licensees may well consider that to have avoided this full payment is a fair exchange for being made to continue to pay royalties over a longer period, perhaps, than would otherwise have been required of them. The Marconi Company, by virtue of its associations, is in a strong position to acquire future patents of importance, and these being in future at the disposal of the licensees is undoubtedly another attractive point in the terms of the agreement.

The new agreement is certainly a compromise but, taking into consideration the strong position created for the patent owners as a result of the successful legal appeal, it is satisfactory to the licensees from most points of view. Even an unsatisfactory agreement might have been better than a prolongation of the unsettled situation of the past months.

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The Use of Anode Current—Anode Voltage Curves for— GRID BIAS VALUES — Determining Input and Output Operating Conditions.

By W. I. G. PAGE, B.Sc.

WHEN we purchase a receiving valve there will probably be contained within the carton a slip reminding us how much we have spent and giving the conventional anode-grid characteristics. These will take the form of the upper part of Fig. 1, which has been traced from the official curves issued for a well-known small output valve. The grid bias recommended by the makers for 150 volts H.T. for amplifying conditions is 6 volts negative, which is marked X in the figure. Since grid current in power valves seldom flows to the left of zero grid volts—and even if it does the affected grid voltage is insignificant in value when compared with the total grid swing—it must be assumed that we are at liberty to allow the signal to swing to zero grid volts on the right (H) and to −12 grid volts on the left (K), for a signal voltage makes equal excursions on either side of the bias point.

Thus the permissible grid swing with an output valve can be safely taken as twice the recommended bias, unless is be expressly stated by the makers that the valve must be overbiased to prevent excessive heating of the anode. When applying the permissible 12-volt swing KH (Fig. 1) to the point X the anode current for the positive half cycle rises to L, or 10.8 mA. from 2.6 mA., and drops from the latter figure to zero at the negative peak of the swing. The two output half-cycles will be extremely asymmetrical, and serious rectification and distortion will apparently take place. Has the valve manufacturer made a mistake or has he overbiased to be able to quote a low average anode current—such an important feature in portable sets?

THE author pleads for the publication by valve manufacturers of anode current—anode voltage curves rather than the more conventional grid voltage—anode current characteristics. It is shown that only with such curves is it possible for the grid potential to be properly adjusted to give the minimum distortion with the greatest possible amplification. There is also considerable information in this article with regard to the effect on grid bias of the early flow of grid current with indirectly heated valves and the alteration from normal bias that has to be made when the filaments of power valves are directly fed with raw A.C.

The Bias Point and the Anode Load.

The answer is that the curves of Fig. 1 are of little use for bias considerations and must be redrawn in another form, taking into account the anode load. As the anode current increases there will be an increasing voltage drop across the load, the anode voltage will drop, and *vice versa*. The dynamic curve can then be found quite easily if it be assumed that the load (loud speaker impedance) is a resistance choke filter-fed in the ordinary way. *Every volt change on the grid means a simultaneous change both of volts and milliamps on the plate*, so that an examination of the working conditions for *a constant plate voltage* as in Fig. 1 gives entirely erroneous results because the anode voltage is changing all the time and is only 150 volts for a fleeting moment when the signal makes the grid potential exactly 6 volts negative. Neither does the positive peak H cause the anode current to be 10.8 mA. (L), nor does the negative peak K mean a drop to zero.

How to Calculate Correct Bias.

By taking the points of intersection of each grid voltage marked and the four constant anode voltage curves (Fig. 1) a new set of characteristics can be drawn as in Fig. 2 giving anode current—anode volts curves for constant grid voltages of equal increment. As an example the Eg − 4 curve intersections are D E F G in Fig. 1 and are shown again in Fig. 2 with the same lettering. In a similar way the other curves are drawn or in the case of Eg − 12 and Eg − 14 are, unfortunately, estimated.

In our early discussion of Fig. 1, in which static conditions were assumed for the plate circuit, no account was taken of the effect of A.C. on the load. We are now concerned with peak voltages which may have an instantaneous value very much greater than the steady voltage of the H.T. battery (or eliminator). If the anode characteristics of Fig. 2 are to give a complete interpretation of working conditions we must ask the valve manufacturers for curves of plate voltages up to at least twice the maximum battery voltage; in the case in question 300 volts.

We can fix the mean working point in Fig. 2 as O, which is the same as X in Fig. 1 (6 volts bias, 150 volts H.T. and 2.6 mA); this point will represent the state of affairs when no signal is being impressed on the grid. When the total permissible grid swing (12 volts) as limited by the 6 volt bias is applied, the working line will start at Eg = 0, cut O and terminate at Eg − 12, and the angle of this line will depend on the A.C. resistance R of the load. By Ohm's law R (ohms) $= \frac{\text{change of volts}}{\text{change of amps}}$

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Grid Bias Values.—

and we may hazard the guess, since the valve's A.C. resistance under working conditions is some 10,000 ohms, that the best load will be about 20,000 ohms. The line A B has been so pivoted at O that 100 volts anode change is accompanied by 5 mA. (0.005 amp.) change in anode current, making $R = \frac{100}{0.005} = 20{,}000$ ohms. Other angles of A B, that is other values of R, may be tried but it will be found that the greatest output for the minimum distortion will be obtainable with the load value already referred to.

If A O is not more than $\frac{11}{9}$ths of OB, the second harmonic distortion will not exceed 5 per cent., which is unobjectionable. For further details of the 5 per cent. distortion scale which is shown against A B, the reader is referred to an article entitled "Valve Data," which appeared in the issue dated December 4th. Had the bias point been fixed originally at −8 volts, the load line of 20,000 ohms from $Eg = 0$ passing through O to $Eg - 16$ would not only give serious distortion as checked by the distortion scale, but a region of zero anode current would be entered. If the bias has been fixed at −4 volts as is suggested by the type of curve (Fig. 1) issued by the maker, the valve would be underloaded and the *power output would be more than halved,* although the bias had only been reduced by 2 volts. Thus the manufacturer has gone to some pains to arrive at the optimum bias point for maximum undistorted output, but the curves supplied give no clue to working conditions and are liable to mislead all but those who have taken the trouble to convert them to the type in Fig. 2. Besides giving the bias point for an output valve for minimum distortion with best value of load, these curves show the A.C. milliwatts developed in the load by making A B the hypotenuse of a right-angled triangle and multiplying together A C and C B as milliamps. and volts and dividing by 8 (in this case about 60 milliwatts).

There appears to be a very urgent need for the publication of anode current—anode volts curves up to high values of H.T., for it is only with their help that many phenomena can be studied both in radio- and audio-frequency circuits. For example, an anode-bend detector when followed by a suitable L.F. transformer provides an extremely small capacitative load to H.F. and the load line can be taken as approximately vertical (R = O when change in volts = O). In Fig. 2 M O N represents such a condition and as the working characteristic swings up and down a constant anode voltage, there would seem to be here an isolated case where the bias can be fixed from the curves of Fig. 1. Even so, the curves of Fig. 2 would be more helpful in determining rectification efficiency and the percentage harmonic distortion with varying depths of modulation. With output valves we have accepted the load as a pure resistance, actually it is usually inductive, and, because the current will lag behind the voltage, the upward swing of the working characteristic will not coincide with the downward swing resulting in an ellipse (see Fig. 3).

With screen-grid valves it is essential to use the anode volts—anode current curves, for without them the limits of safe anode swing without encroaching upon the negative resistance "kink" cannot be seen. In Fig. 4 curves of one of the new S.G. valves are shown. The working characteristics should apparently be within the dotted rectangle to ensure linear amplification without rectification. An excursion to the left of the rectangle where the $Eg = O$ curve shows the valve to have a comparatively

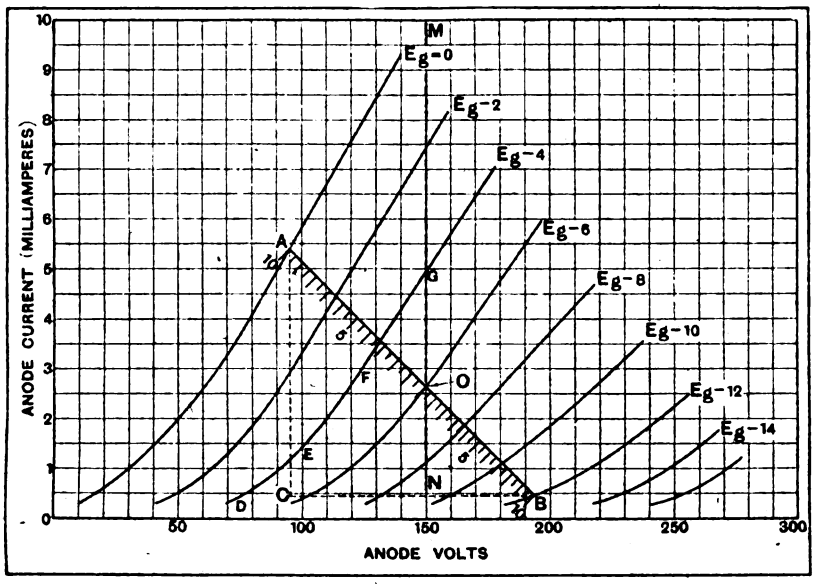

Fig. 2.—Anode current—anode volts curves for equal increments of grid volts (Eg) plotted from Fig. 1. From this family of characteristics the working conditions are easily followed. The bias of 6 volts can be seen to give practically no rectification and the best output load can be calculated from the angle of A B. The actual undistorted A.C. watts developed are measurable from the area of the triangle A B C.

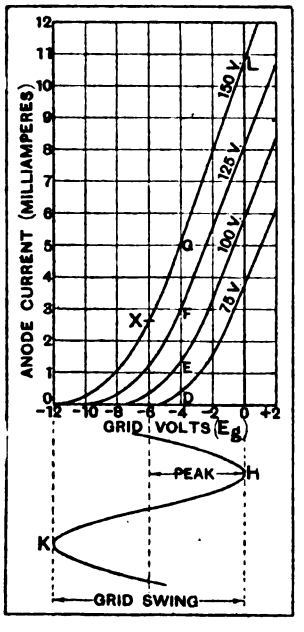

Fig. 1.—Conventional grid voltage—anode current curves for a popular small output valve. Although an optimum bias of 6 volts for 150 anode volts is given by the manufacturers for amplifying conditions, it is seen that a 12-volt grid swing KH would be seriously rectified if operating conditions are viewed from these characteristics.

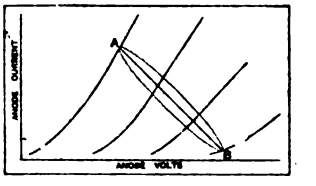

Fig. 3.—With an inductive load the anode current—anode volts characteristic swings up and down in the form of an ellipse A B since the current lags behind the voltage. As an approximation the axis of the ellipse can be taken to represent the load line.

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Grid Bias Values.—

low impedance might affect selectivity. The load line shown represents a coupling with a dynamic resistance of about 40,000 ohms at resonance—indeed a poor inductance with the losses of a bad plug-in coil. If a load of about 250,000 ohms (a good Litz coil) were drawn with its operating point at $Eg-1.5$, the line would be nearly horizontal, suggesting an extremely limited grid swing for 150 anode volts. Further study of such curves might reveal the cause of the mysterious lack of selectivity with S.G. valves when used with H.F. transformers of optimum ratio.

With pentodes the production of dangerous anode voltages up to seven times that of the H.T. battery, and the fact that very low impedance loads must be used, would not have been brought to light without a careful study of the anode characteristics.[1] In brief it may be said that the bias point and general operating conditions for triodes, pentodes and screen-grid valves can only be found by an examination of the anode curves plotted for constant grid volts, and the author feels that his plea for the general publication of such curves is justified.

It has already been stated earlier in this article that with output valves, if there is any flow of grid current to the left of zero grid volts, it affects such a proportionately small amount of the total grid swing that the bias need

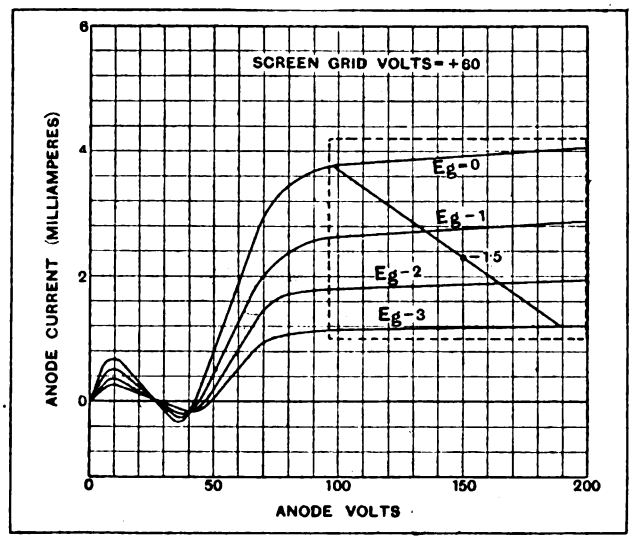

Fig. 4.—Anode characteristics of one of the new screen-grid valves. To avoid rectification the load line should be restricted to the area within the dotted rectangle.

hardly be increased. With H.F. valves and detectors accepting but small inputs the position is different. The increasing popularity of all-mains receivers has led to the widespread use of indirectly heated A.C. valves in which grid current may flow at negative grid voltages. The reason is that electrons are shot off from a cathode or filament just as irregularly as steam is emitted from a saucepan of boiling water. Some electrons start with sufficient velocity to overcome a very small negative voltage on the grid, others have but a small initial velocity and will not form part of the grid current. When there is a voltage drop down the filament, as with the battery-fed type of valve for 2-, 4- and 6-volt accumulators, the positive end of the filament is at a considerably more positive voltage with respect to the grid than the negative end of the filament.

If the grid is connected to the negative end of the filament in a 6-volt valve such as the P.625, the grid is at a potential which is 6 volts negative with respect to the positive end of the filament and only a small portion of the negative end of the filament will produce grid current which will start to flow on the right of zero grid volts (see Fig. 5). In a valve with an indirectly heated cathode there is no potential difference between the ends of the emitter and the whole surface of the latter contributes towards grid current, which will probably start on the left of zero grid volts (see curves on the left in Fig. 5).

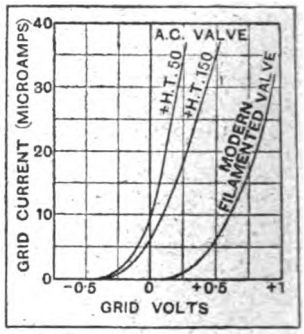

Fig. 5.—Grid current curves for A.C. and ordinary filamented valves.

Grid current curves start at about the same point on the grid base for varying anode voltages, but less current will flow the higher the H.T. pressure, since the plate will begin to rob the grid of the electrons which it has claimed at the lower voltages (Fig. 5). While it is important in the interests of maximum signal strength to bias H.F. valves (neutralised triodes and S.G. valves) as near to zero grid volts as possible, it is desirable to apply a minimum of 1½ volts negative to H.F. valves with independent A.C. cathodes. With an ordinary filamented triode a fraction of a volt is enough. An A.C. valve usually has sufficient grid current flowing at zero grid volts to allow of its use as a leaky grid-detector without any applied positive bias, provided the anode volts are kept low (40-60 volts).

The prevailing practice of employing in the last stage of a mains receiver a power valve directly heated with A.C., suggests a few notes on the problems of bias in the circumstances. Assuming that the grid return is taken to the electrical mid-point, we must use a greater bias than is correct for D.C. because (1) we have actually altered the "static bias" on the grid by removing the steady potential drop along the filament and we have also slightly increased the effective anode voltage by the same means; (2) assuming the grid current to start originally at zero grid volts, we have now to take care that the grid does not in effect swing positive, due to the peak value of the A.C. voltage on the filament. The bias which we have to add must compensate for whichever of the above two effects is the greater. The changes in (1) will be taken care of by making the bias more negative by an amount $E_f/2+E_f/2\mu$ where E_f is filament voltage and μ the amplification factor of the valve. The change of bias due to the removal of the steady drop along the filament is compensated for by $E_f/2$, while $E_f/2\mu$ cares for the effective increase of anode voltage. The potential change alluded to in (2) will be $\sqrt{2}\times E_f/2$, i.e., $E_f/\sqrt{2}$. When these two effects are equal we have $\frac{1}{2}+\frac{1}{2}\mu=1/\sqrt{2}$ that is, $\mu=2.4$ approximately. Thus if μ exceeds 2.4 the additional bias is $E_f/\sqrt{2}$.

[1] See *The Wireless World*, December 4th, 1929, page 630.

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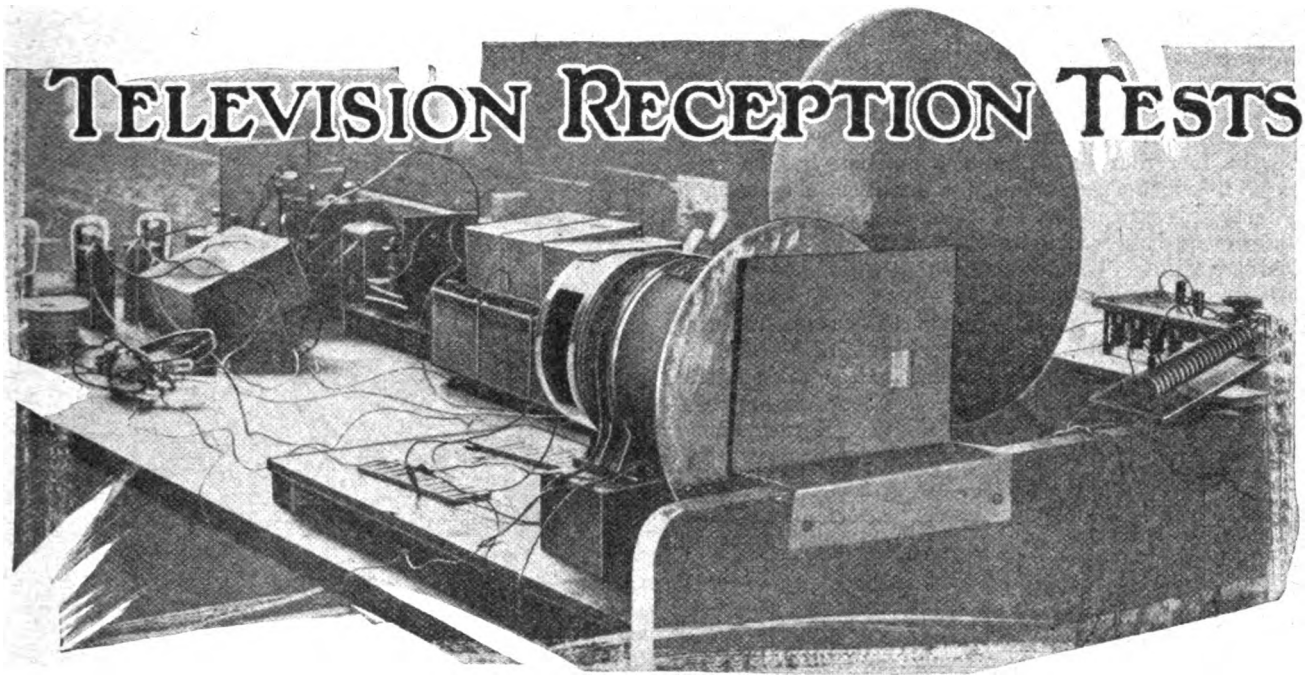


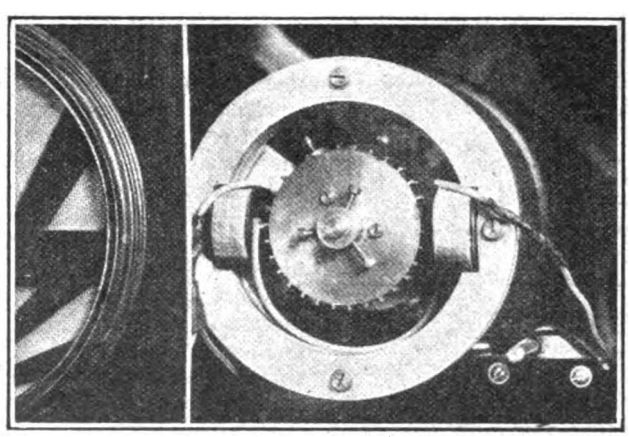
TELEVISION RECEPTION TESTS

An Endeavour to Receive the Television Broadcast, with Details of the Apparatus Used.

By F. H. HAYNES.

BUT for the fact that an experimental television broadcast is being conducted from the London regional station there would have been no justification for this article. So limited is a technical study of the apparatus now used in television that, in reviewing the present situation, a few words must necessarily be devoted to the Baird organisation, which is responsible for the transmissions, and the part played by the Post Office and the B.B.C. As a determined experimenter not to be deterred from his objective by the failure or criticism of others, Mr. John L. Baird has earned for himself the highest praise. His early apparatus was first described in the issues of this journal of May 7th, 1924, and January 21st, 1925, which, while revealing little that was new and an advance on the work of earlier experimenters, showed that he was intensively applying himself to the practical side of the problem. A mechanical analyser was used consisting of a disc carrying a spiral of lenses, the carrier frequency was introduced by a serrated wheel, and the light sensitive device was said to be colloidal. Valve amplification was a new factor, so that it became possible for him to use a neon tube as a source of image-forming light at the receiver. Since that time another contribution of vital importance to television has been the perfecting of the photo-electric cell, and we can say that the valve amplifier, the neon lamp, and the photo cell have made the demonstration of television possible; yet the application of these new devices is but an obvious modification.

Knowing that the real difficulty in television is that of synchronising the revolving mechanism at transmitter and receiver, no inventor can claim success who does not first put forward a solution to this problem. In his earliest apparatus Baird used A.C. synchronising, such as had been adopted previously in several systems, and was described by Campbell Swinton. In this respect the Baird gear represented no advance on the work of others. Synchronising by A.C. consists of feeding a common A.C. current to both transmitter and receiver which, with the aid of a synchronous motors, tuning forks or relays, effectively holds



The toothed-wheel synchroniser fitted in the Baird television receiver.

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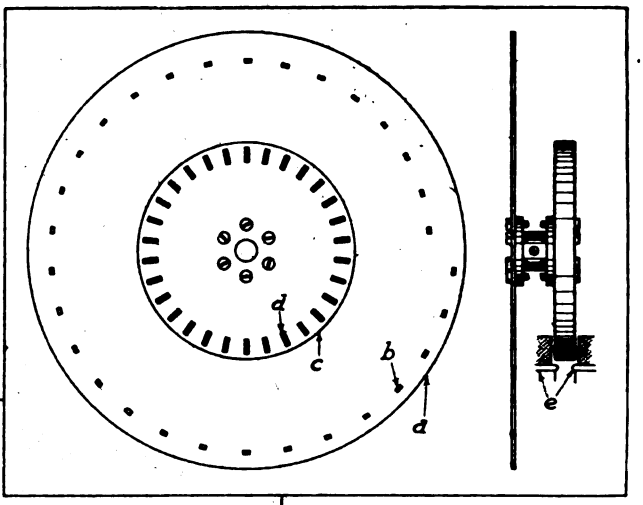
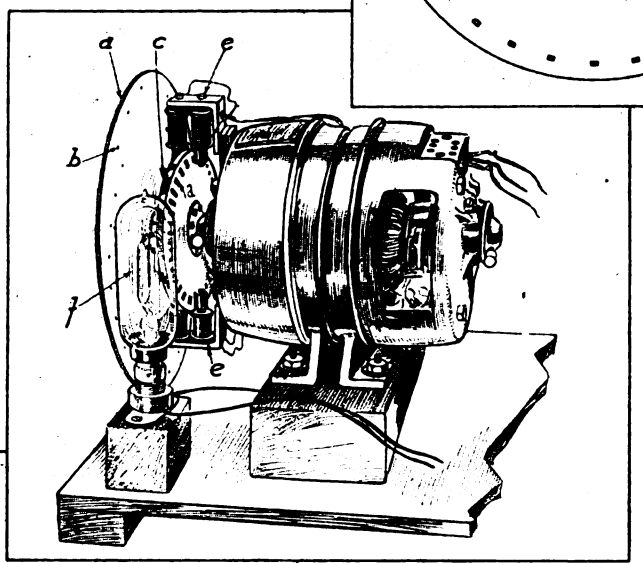
the rotating parts in step. This method demands an additional channel between transmitter and receiver in order that both the picture-forming and synchronising signals may be separately conveyed. In spite of the existence of this all-important problem of synchronising and the fact that no patent specification has yet appeared in which a new solution is disclosed, it is thought in many quarters to-day that television is making vast strides towards becoming an accomplishment as familiar as broadcasting. We now know that Baird had no important contribution to make in solving the synchronising problem. The situation might have remained unchanged following the early experiments of Baird had not financial assistance been sought and a development company formed to convert the Baird apparatus into a marketable article. More recently a larger company acquired the Baird interests in this country, the principal object being that of manufacturing television reception gear for use in conjunction with our broadcasting service. In this connection another almost insurmountable problem presents itself.

The Frequency Limitation.

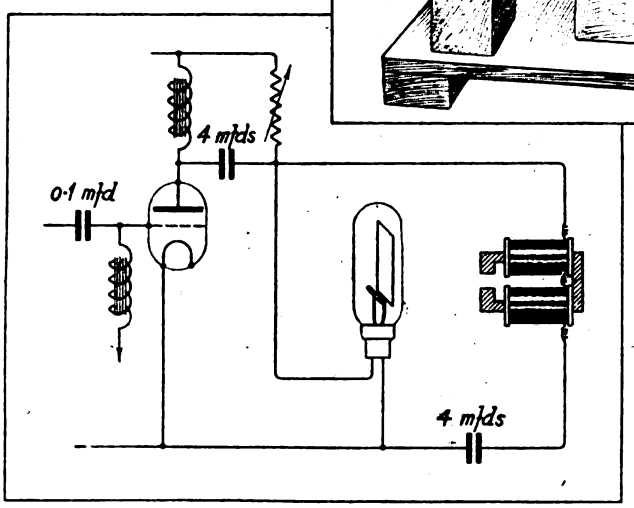
When analysing a picture into a number of points of light of varying intensity, an enormous number of individual signals are formed, and we know that the complete image must be transmitted in a period of time not longer than one-tenth of a second if a moving picture effect is to be produced. Unless a very severe limit is imposed, therefore, on the size of the image, and the extent or "fineness" of analysis, the number of signals to be transmitted within a second far exceeds in value the highest audio frequency that can be dealt with in broadcast. So long as the picture is kept small and a coarse degree of analysis used, radio transmission is possible, assuming, of course, that a solution is found to the difficulties of synchronising.



Constructional details of scanning and synchronising discs.



Experimental television receiver. (a) scanning disc, (b) spiral of 30 holes, (c) light fibre synchronising disc, (d) soft iron segments, (e) magnets carrying the picture signals, (f) the neon lamp.



Circuit arrangement of an output stage in which the picture signals are passed to an electromagnet in order that the current peaks may produce synchronising.

We remember the publicity given to the negotiations between the Baird Company and the broadcasting authorities concerning the inclusion of television transmissions in our broadcast programmes. From the statements issued it appeared that the B.B.C. was opposed to being a partner in such an undertaking, this attitude being based upon technical considerations. Negotiations were pursued, however, and on the intervention of the Post Office we now have the experimental television broadcast service. Transmissions are made from 11 a.m. to 11.30 a.m. daily, Saturdays and Sundays excepted. It is understood that this series of television transmissions is now being extended to include, in addition, two nights a week after broadcasting hours.

Enquiries are being made in many quarters as to the success of these transmissions, which have now been in progress for some eight weeks. Listeners ask where suitable receiving gear can be obtained, and radio enthusiasts seek technical details of experimental apparatus with which to participate in the tests. Can this television broadcast be successfully received, and, if so, what is the quality of the pictures? It was with

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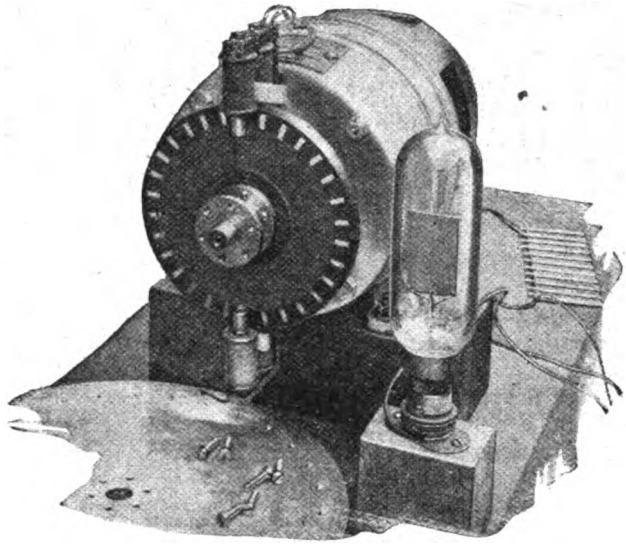
the object of answering these questions that the apparatus to be described came into being.

Details of the Baird method of synchronising were made public last September. The apparatus was shown to be extremely simple, and to consist of a toothed wheel mounted on the shaft of the motor driving the analysing ("scanning") disc. Just clearing the teeth are the poles of an electromagnet, the signal currents being applied to the magnet winding. A very similar arrangement of phonic wheel has already been described in this journal when reviewing the Mihály system of television.[1] Assuming that a break exists between each successive picture, then a similar moment of no signal must likewise occur after the formation of each transverse picture-forming strip. With a number of teeth equal to the number of holes in the disc and the poles of the magnet engaging the teeth during the period of no signal, it is thought possible that the picture signals may be used as a means of synchronising. Thus at a time of no current through the magnet windings the teeth will travel unimpeded past the poles. Should, however, the disc be running slightly too fast the picture-forming current will be energising the magnet pending the interval of no signal being reached. There will thus be a retarding action tending to correctly regulate the speed of running and the precise position of the disc at any interval of time. Whether or not the toothed wheel is controlled by an interval of no signal between each image-forming picture strip or is, in fact, pulled into position by the current representing a bright line across the picture is immaterial. What most probably is the intention is that the bright parts of the picture representing successive peaks of current with each traverse have an accelerating or retarding action upon the rotation.

Unless a generous bank of power valves be used for energising the electromagnet its influence will be inadequate to control the rotation. Whether the power thus available is sufficient to control the disc will depend upon the weight and speed of the revolving parts and the amount of correction required. When one considers that the initial driving power is supplied by a motor running at a speed of over 700 r.p.m., and that the restraining influence of the synchronising current is only applied for a brief interval of time, it will be readily realised that considerable energy will be needed to check even a small variation. Lightness of moving parts and a minimum of friction for the motor to overcome are the aims in setting up the apparatus, while provision must be made to regulate very critically the speed of the motor. A slow-speed motor with ball-race bearing having an armature and commutator of the smallest permissible diameter was selected after making several tests. As to the scanning disc itself, which measured $11\frac{5}{16}$in. in diameter, sheet aluminium was adopted, a little more than $\frac{1}{16}$in. in thickness, after tests had been made with another and much lighter material.



View showing the method of mounting the synchronising disc and its associated electromagnets. The critical speed-adjusting field rheostat can be seen on the right.

Instead of the iron-toothed wheel, as recommended by Baird, one of fibre was constructed slightly larger in diameter than was indicated, so as to provide a more critical control and yet possessing quite moderate weight. To avoid the windage of projecting teeth, which it was quickly realised was appreciable at the normal running speed, small iron bars were pressed into a fibre disc, and their ends turned down flush with the faces. Precise details of the disc can be gleaned from the illustrations. Every care was taken to ensure correct spacing between the bars and that they passed through the disc at exact right angles to the faces. Maximum magnetic flux for the watts available was thus produced by the short magnetic circuit when these bars passed between the poles of an electromagnet. Two magnets were actually used in order to get the strongest magnetising effect without saturating the iron. As there was no end play on the motor shaft, exceedingly small clearances were possible between the poles and the disc, and this is, of course, an important condition, seeing that the watts used to produce a given magnetic flux increase approximately as the square of the width of the gap increases. So small were the clearances, in fact, that when the signal currents were applied a slight pulling in of the poles occurred, and, in order to prevent rubbing, it was necessary to insert wooden wedges between the end cheeks of the bobbins.

IS it possible to receive in the average home the television broadcasts now taking place from 2LO? The test apparatus made up with a view to answering this question is here described together with details of the results obtained. Unlike most scientific achievements uncertainty exists as to whether the claims of success have been substantiated.

The recent announcement that 1,000 receiving sets will shortly be available, and that the television transmissions are being extended has created a demand for precise technical information concerning the apparatus and its performance.

[1] Television by the Mihály System, July 3rd, 1929.

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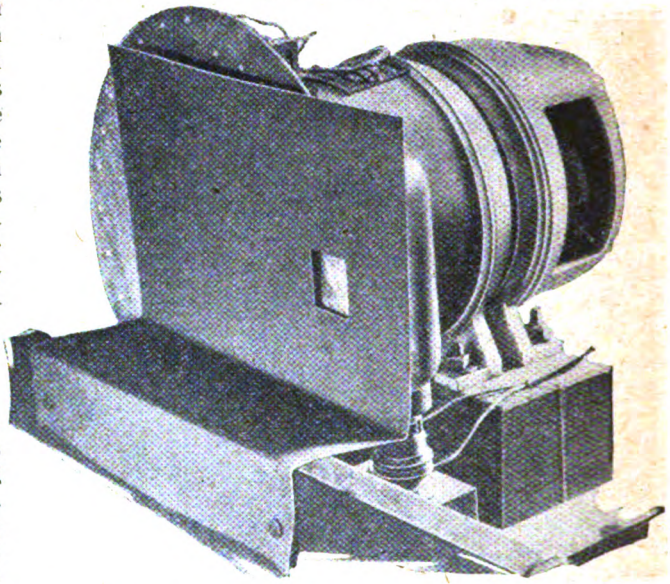
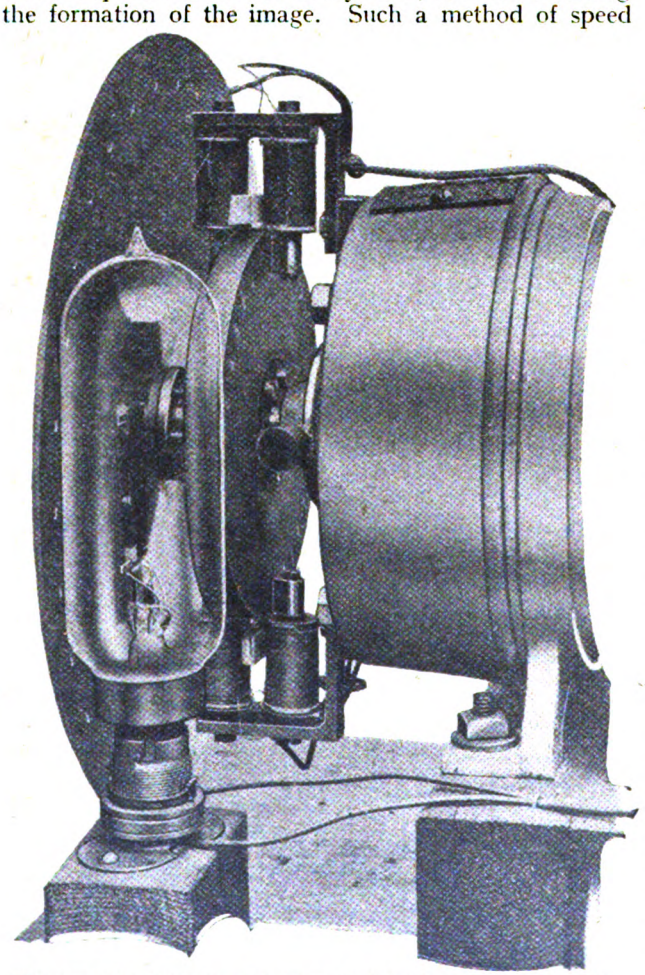
A brass bush coupled the synchronising and scanning discs. In the absence of published information it became necessary to conduct some preliminary tests in order to discover the direction of the spiral of holes in the scanning disc, the pitch of the spiral, together with the size and position of the image. Quickly it was realised that reasonable precision was necessary in the positioning of the holes, and that a small error in the setting out of any one hole produced a dark strip when the disc was rotated before a source of light. It was noted also that for uniformity of illumination when receiving a picture that the holes should not be precisely round, and that their exact shape, which more probably approaches a rectangle, can, no doubt, be readily calculated, bearing in mind also the hole-shape used in the scanning disc at the transmitter.

Speed Regulation.

Critical speed control was arranged by variable resistances in the field and armature circuits of the motor, so that an almost correct running speed was maintained with a minimum of current. Part of the resistance controlling the field was brought out to a short-circuiting switch in accordance with popular American practice, so that the speed could be critically checked while watching the formation of the image. Such a method of speed control, while being crude and entirely unsatisfactory in a commercial product, is as helpful as anything in the hands of the experimenter. Attention was particularly turned to an endeavour to successfully operate the synchronising device. With a power output valve such as the P.625, which can be run from a normal source of H.T. supply, it cannot be seen how sufficient control of the disc can be obtained. By fully loading its grid with an alternating current, and experimentally adjusting the impedance of the magnet so as to obtain a maximum power output at the given frequency, the control provided by a valve of this class proved entirely inadequate. In making this observation it must be borne in mind that the magnets are only acting at brief intervals.



A card is used to "frame" the image while a magnifying lens was improvised so that the details could be more carefully examined.



The complete apparatus as assembled on the end of the motor.

Tests with Generous Output Stage.

The next step was to arrange a generous output power stage, and the arrangement finally set up consisted of no fewer than three of the new LS6A valves with fully loaded grids, as revealed by microammeter and milliammeter, and working with the maximum rated anode voltage of 400. Even so generous an output stage as this proved insufficient to produce stable and automatic synchronising. When the grids of the output valves, however, were fed with alternating current, the effect was different, and, in spite of the comparatively high speed of rotation, synchronising with the A.C. voltage was at once possible, as was to be expected from previous experience with a phonic wheel. Owing probably to the irregular wave-shape of the picture-forming signal this type of synchronising, as suggested by Baird, cannot be regarded as satisfactory. Maybe by mere coincidence the regional scheme will provide an acceptable solution to the problem, in that while one transmitter will convey the picture signals, the other can provide an alternating current controlled by the analysing disc at the transmitter. Such a proposal differs vastly from the existing claims as to the possibilities of a television broadcast

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service, and would entail the use of a twin receiving equipment.

As to the results obtained it may be stated that pictures were received within the first ten minutes of using the apparatus, but the synchronising was not automatic and success depended upon the very careful manipulation of the field regulating switch, combined with frequent frictioning of the disc. For the most part the successive pictures appeared as parallelograms rising and falling before the aperture. With the rising or falling string of pictures one soon learns how to speed up or retard the disc, yet an apparatus demanding such a procedure possesses no commercial merit. The neon tube functioned well, and after critically adjusting the threshold and signal voltages the contrast of the image was brought down from the harshness which it possessed at the commencement of the tests. Detail was poor, due, perhaps, in some measure to small inaccuracies in the location of the holes and to the continuously changing position of the picture. Two types of tube were tested, with equal success, one a product of the General Electric Company and the other a Raytheon Kino-lamp (Rothermel).

It is probable that the scanning disc used was incorrectly divided in that the pitch of the spiral was excessive as compared with the mean circumference. In the absence of information it is suggested that some 50 per cent. of the signal is taken up by the synchronising mechanism so that the height of the picture is only about one-half the distance between successive holes. This reduction in the height of the image demands a smaller pitch for the spiral in order to maintain the correct height to width ratio. Actually the holes in the disc were very much smaller than they appear in the illustrations, the apparent large size being due to countersinking. Assuming that nearly half the signal energy is thus applied to the windings of the magnets, and this would seem to be the case from these tests, the successful working of the apparatus can be anticipated. A bright margin observed between successive pictures indicates the inclusion in the transmission of a definite synchronising signal.

In addition to the apparatus referred to here other forms of gear were tested. An attempt was made to rotate a light paxolin disc with a powerful audio-frequency oscillator adjusted closely to the picture frequency and to which the picture signals were coupled. It was the hope that the peaks in the signals would drag the oscillator precisely into step. Insufficient power, however, was produced to maintain the high speed of rotation, while practical difficulties in combining an incoming signal with the local oscillator made the arrangement unworkable.

Transmission but no Reception.

Against the observations recorded here may be quoted the fact that successful public demonstrations have been claimed. Other than at the Olympia demonstration and that which is frequently given at the Baird studios, where in both instances the transmitting and receiving equipments are set up in adjoining rooms, no details can be gleaned of successful television reception possessing commercial possibilities and operating under conditions similar to those existing in the home of the broadcast listener. While much is being written on the obscure electrical and light problems involved in television the writer is unaware of any single instance of an experimenter coming forward claiming successful results and inviting investigation. We will be better able to judge the fulfilment of the claims made when Baird receiving equipments become available, and one cannot but draw attention to the extraordinary position which exists under which the transmissions have come into being without even the standards of transmission being disclosed to the public or a single specimen instrument being procurable. Television receiving sets are to be available shortly, and, according to a statement by the Baird Company, one thousand instruments will be completed during the month of January, and whilst one must assume that machines already exist it has not been the good fortune of the writer to be favoured with an early specimen in order that its successful working might be endorsed. "Television is here" has so long been the cry that failure in its fulfilment is sufficient contradiction of its truth. It has long been hoped that in television the amateur will find a new field of experiment, and with the introduction of receiving equipments in the course of the next few weeks an opportunity will be afforded to judge its potentialities. In the meatime a statement from the B.B.C. as to the nature of the reception, which, one must assume, they are investigating, would be welcomed.

BOOKS RECEIVED.

Elements of Radio Communication, by J. H. Morecroft. A text-book for students giving the general principles of wireless telegraphy and telephony in a concise form and without the use of advanced mathematics, comprising the simple laws of the electric circuit; special laws for radio circuits; general idea of radio communication; the valve and its uses; telegraphy; telephony; and typical receiving sets. Pp. 269+x, with 170 illustrations and diagrams. Published by J. Wiley and Sons, Inc., New York, and Chapman and Hall, Ltd., London. Price 15s. net.

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The Fundamentals of Radio, by Prof. R. R. Ramsey, Ph.D. of Indiana University, U.S.A.

A text-book for students, comprising the general theory of electricity and the principles and practice of radio telegraphy and telephony. Pp. 372+xi, with numerous illustrations and diagrams.

Published by the Ramsey Publishing Co., Bloomington, Indiana, U.S.A., price $3.50.

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A.T.I. (Annuaire Téléphonique International)—The first edition of the International Telephone Directory in English, French and German. Containing the charges for long-distance telephone conversations between Continental towns and a list of 12,120 names, addresses and telephone numbers of manufacturers, hotels, traders, etc., in 1,485 towns of 27 different European countries. These are classified under their trades, but a further alphabetical index of their names is provided in which they are grouped according to their respective countries. The directory is published in Copenhagen, and the editors, while admitting that this first edition naturally falls far short of the objects they have in view, hope that its utility will be so universally recognised by firms doing foreign business that subsequent editions will become more and more complete. The sole agents for Great Britain are Messrs. Rassey Bros., 28, Basinghall Street, London, E.C.2.

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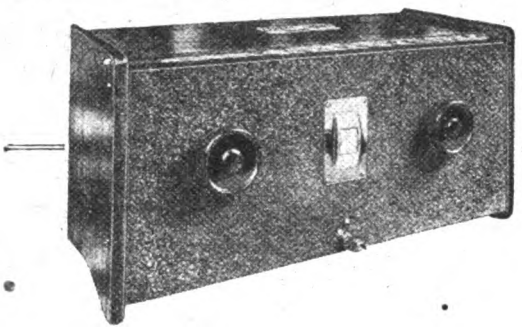


KIT CONSTRUCTORS' NOTES

The New Osram Music Magnet.

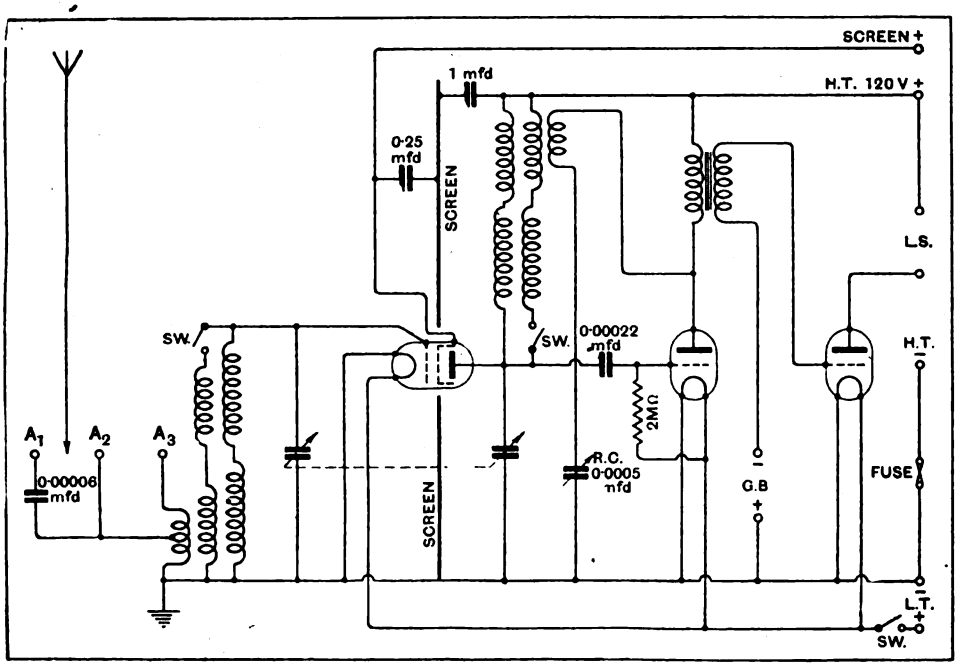
THAT the basic essential features of the original Osram Music Magnet have been found suitable to be included in their entirety in this season's model must surely be a matter for justifiable self-congratulation on the part of those responsible for it. In a rapidly developing art such as ours, no better proof of excellence exists than that a design—particularly one of an ambitious and unconventional kind—should not only survive, but actually flourish, after the acid test of a year's trial.

It must be a pleasant task—it is certainly still a comparatively unusual one—for a wireless set designer to be relieved of the necessity for producing something entirely new, and to be able to concentrate all his energies on improving his original conception in detail. However carefully the job may have been done in the first place, experience nearly always shows minor crudities or imperfections to be smoothed away, and desirable additions to be made.

The set under review provides an example of what can be done when working on these lines. Although it is externally similar to its prototype, critical examination shows that hardly a single detail remains unchanged. Alterations are found in the arrangement of the filament wiring; originally, there was considerable risk of burning out valves by an accidental short-circuit, but, by connecting H.T. negative to L.T. negative and fitting an on-off switch (insulated from the metal panel) in the positive L.T. lead, the receiver is rendered as safe, and even fool-proof, as is possible. As an extra precaution, a safety fuse is inserted in the H.T. negative lead.

An improved mounting for the H.F. valve is provided; although it is still carried in a spring holder, a fairly rigid metal spring is used for making connection with the anode terminal.

The coil assemblies have been simplified, and now consist of two concentric formers, the inner carrying the medium-wave inductance and the outer the long-wave coil; there is also a third section which, as the coils are interchangeable in grid or anode circuits, functions as either "aperiodic" aerial or reaction winding. The coils have a very limited external field, as each of the tuned inductances comprise two windings in opposite direction. For working on the long waves, one section only is used, while for the medium band, both are placed in parallel by the action of built-in roller switches. One is apt to criticise the position of these switches on the score of inaccessibility—the lid of the box must be opened to change wavebands—but any other plan would introduce undesirable complications.



Circuit diagram, showing details of waveband switching.

Complete ganging of the two tuned circuits is, of course, still a leading feature of the design, and an important innovation this year is the provision of direct wavelength calibration; indications are marked on the dial every 50 and 200 metres for the medium and long wavebands respectively. This is a most attractive and valuable feature.

It will be unnecessary to enumerate all the details in which the present set differs from the original, but mention should be made of the improved condenser friction drive, which operates well and is quite easy to set up, and of the

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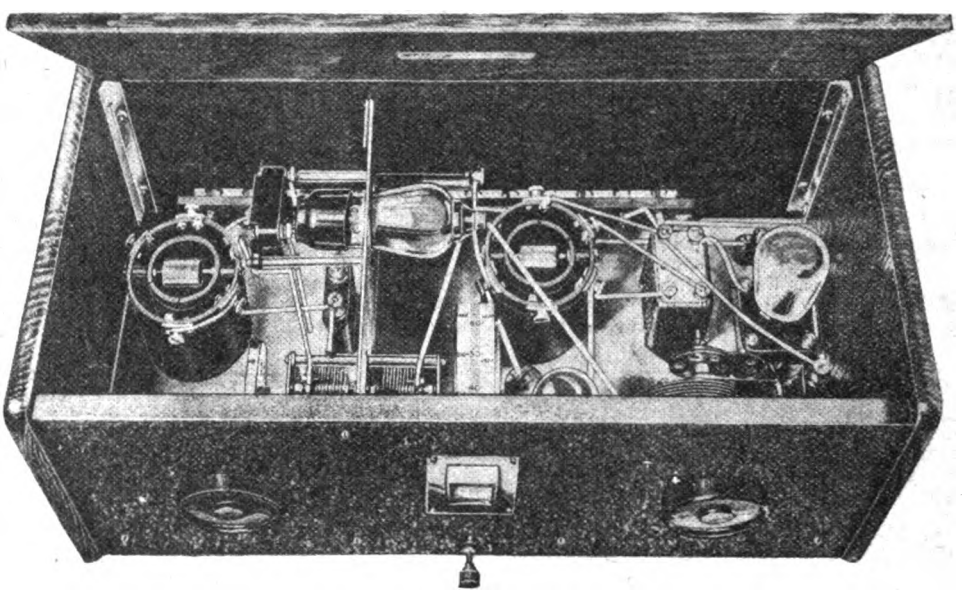
Kit Constructors' Notes.—

fact that a good-looking polished oak cabinet, supplied in sections ready for easy assembly, is now included in the set of parts. The efficient L.F. transformer is of a new type, with high-permeability core.

The diagram given shows that the circuit is a fairly conventional arrangement of H.F. amplifier, detector, and one L.F. stage. Aerial coupling is through a double-wound transformer with three optional connections for varying selectivity. By joining the aerial to A_3, the complete primary winding is in circuit and signal strength is (almost invariably) at a maximum; greater selectivity but generally less sensitivity is afforded by changing to A_2; in this position the number of aerial coupling turns is reduced. The third terminal, A_1, is joined internally to the tapping point on the coupling coil through a very small condenser, and provides high selectivity with considerably weaker signals.

H.F. coupling is through a tuned anode arrangement, and the detector operates on the grid principle. For reaction control, a commendably large value of variable condenser is used, and it should be noted that the primary winding of the L.F. transformer is relied upon to deflect sufficient energy through the feed-back circuit, the usual choke being omitted.

Assembly and wiring of the "kit" submitted for test took precisely 2 hours 55 minutes; this allowed sufficient time to make connections neatly and properly. Prospective constructors may be interested to know that it is wise implicitly to follow the sequence of operations as laid down in the instructional pamphlet, and that apparent short cuts may involve the risk of having to remove parts already assembled. In general, accessibility of the components is excellent, and all the holding down holes register accurately with their counterparts on the sheet aluminium chassis. Care should be taken to see that the lead between terminal No. 4 of the anode coil assembly and the reaction condenser is led well clear of the roller switch in such a way that it does not interfere with its operation. A small spanner is useful for tightening up the various nuts, particularly those on the terminals; the condenser spanner supplied might with advantage be made double ended so as to serve for this purpose.



Interior view, showing dual astatic coils and positions of the more important components.

Satisfactory Ganging.

One's initial impression that the design of the set is particularly well balanced is confirmed on testing it. The H.F. resistance of the coils seems to be just high enough to ensure entirely satisfactory operation of the single-knob tuning control and low enough to afford reasonable sensitivity; with regard to this latter quality, the set behaves every bit as well as many popular receivers with independent tuning condensers.

To obtain high selectivity it is necessary to make full use of the variable coupling provided by the three aerial terminals, and it would be more convenient if these were replaced by sockets. Over most of the tuning scale, there is naturally a considerable drop in volume as coupling is loosened, but this is not so marked when receiving the lower wavelengths on either band. Operated on an indifferent aerial in central London, Brookmans Park was just audible on the setting corresponding to the proposed twin station (261 metres) with the aerial connected to A_3 (least selective adjustment). This slight interference was entirely removed by applying reaction. There was very little spreading of local signals with the weaker coupling provided by connection to A_1 or A_2.

On the medium band, reaction control was found to be smooth, progressive, and almost free from overlap; on the longer waves it was not quite so good, but still satisfactory. Thanks largely to the new L.F. transformer, quality of reproduction is distinctly superior to that of the original model, and, with a super-power L.F. valve in place of the Osram P.215 normally supplied, a still greater undistorted output is obtainable—but, of course, at the expense of an increased H.T. consumption.

Two years ago it would have been considered almost impossible to produce an inexpensive 3-valve set with H.F. amplification, ganged tuning, and wavelength calibration, even under factory conditions, where tests can be applied at various stages of manufacture. It is something of an achievement to have devised means whereby these advantages can be offered to the home constructor in such a way that he is virtually assured of success, provided he applies reasonable care and common sense in assembly and wiring. The complete kit, including valves and cabinet, costs £9, and may fairly be considered as good value for money.

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CURRENT TOPICS.

U.S. FOOTHOLD IN CANADIAN ETHER.

While Britain continues to dally with the project for an Empire broadcasting service, the United States has secured a new mouthpiece for national and commercial propaganda in Canada by the inclusion of station CKGW, Toronto, in the National Broadcasting Company's network. CKGW broadcast its first N.B.C. programme on the American Thanksgiving Day (November 28th), and will in future relay to Canadian listeners regular programmes from New York, Washington, and other cities of the United States.

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WORLD TALKS FROM THE VATICAN.

Work has now begun on the erection of the Papal wireless station in the Vatican City. The apparatus is being built by the Marconi Company.

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RAIN-MADE "STATIC."

During the rainy spell many listeners have imagined that atmospherics have been on the increase. In most cases it has been found that the supposed static has been due to faults in aerial insulation disclosed by the damp.

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FRANCO-TURKISH WIRELESS SERVICE.

A public radio service to Turkey has been opened by the French Post Office. Private and commercial telegrams marked "Voie T.S.F." are sent by this route at the ordinary rates.

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POLICE WIRELESS IN FRANCE.

A network of fifty-one police wireless stations distributed throughout France is provided for in the Budget of the Ministry of the Interior for 1930. The central transmitter will be the Eiffel Tower, says *The Daily Telegraph*, and the calls will be made at an hour's interval during a certain part of the day. Photographs and finger-prints will be included in the transmissions. The receiving stations will be specially equipped for short-wave reception, and their duties will include watching foreign transmissions and searching for illicit stations.

OUR CHRISTMAS-DAY ISSUE.

Special arrangements have been made whereby the issue of *The Wireless World* dated December 25th, will be on sale on Saturday, December 21st.

PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION.

Sir Ambrose Fleming, M.A., D.Sc., F.R.S., lecturing on "Television, Present and Future," will provide one of the attractions of the twentieth annual exhibition of the Physical and Optical Societies.

The exhibition is to be held on Tuesday, Wednesday, and Thursday, January 7th, 8th and 9th, 1930, at the Imperial College of Science, Imperial Institute Road, South Kensington, and will be open in the afternoon from 3 to 6, and in the evening from 7 to 10 p.m.

Over eighty firms have accepted the invitation to exhibit in the trade section at this exhibition, and in addition a group of research and experimental exhibits is being arranged, which will be shown by Fellows of the societies and others, and a number of research laboratories and other institutions. Some interesting historical exhibits will also be included.

Sir Ambrose Fleming's lecture will be given at 8 p.m. on January 9th.

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TREE RENT.

Listeners who have used trees in Enfield Town Park Estate, Middlesex, to support their aerials, are to pay a shilling a year to the Town Council as "rent."

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NEW YEAR "SMALL ADS."

Special holiday printing arrangements make it necessary to close for press earlier than usual with our issue of January 1st. Miscellaneous advertisements for inclusion in that issue should be in our hands not later than first post on Tuesday, December 24th.

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MAZDA VALVES.

In our issue of December 4th we drew attention to the special arrangement of the Edison Swan Electric Co., Ltd., whereby customers who were unable to obtain valves of the new Mazda series from their local dealers could be supplied direct on application to the company. Owing to the large response, the Edison Swan Electric Co., Ltd., regret that this offer must now be withdrawn. Every effort is being made to overtake the demand.

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"WIRELESS FOR THE BLIND" FUND.

With the object of providing every blind person in the United Kingdom and Northern Ireland with a wireless set a Fund has been established, with H.R.H. The Prince of Wales as President. Wholehearted support is being given by the B.B.C., and one of the first moves in the broadcast campaign will be a microphone appeal, to be made by the Rt. Hon. Winston Churchill, M.P., at 9.20 p.m. on Christmas Day from all B.B.C. stations.

It is estimated that 15,000 blind people throughout the country need sets.

All donations to this Fund should be sent to the Rt. Hon. Reginald McKenna, Hon. Treasurer, British "Wireless for the Blind" Fund, 226, Great Portland Street, London, W.1.

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MAN'S INGRATITUDE TO MAN.

That broadcasting for love is a thankless task is the discovery of the Radio Club of Burma, which has received numerous complaints from Rangoon that its programmes do not come up to the expected standard. More in sorrow than in anger, the president of the club is asking the Government to erect a powerful station which can be heard all over the province. The Radio Club's transmitter has a power of only 750 watts, and funds are scarce owing to the fact that the club, unlike the broadcasting companies, draws no revenue from the wireless import duties.

FOR THE WORLD'S FASTEST LIFEBOAT.—The totally enclosed wireless telephony transmitter and receiver installed by the Marconi Company in the new Dover lifeboat, the fastest in existence. Known as the type XMB.1., the set uses a transmitting power of 100 watts on a wavelength of 900 metres, and is designed for work under the roughest conditions. The lifeboat is specially equipped for aircraft rescue work.

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HOW WE HEAR

The Ear Corrects certain Loud Speaker Defects and Acts as an Amplifier, Rectifier and Frequency Analyser.

By R. T. BEATTY, M.A., B.E., D.Sc.

(*Continued from page 652 of previous issue.*)

PHYSIOLOGISTS find that both motor nerves (those which transmit orders *from* the brain) and sensory nerves (those which transmit messages *to* the brain) behave exactly alike. Messages pass along both kinds of nerve at an average speed of 100 metres per second, or 220 miles per hour—a rate which is too slow to be of an electrical nature and which is ascribed to chemical action; this action is, however, accompanied by an electrical effect, which can be amplified and recorded by a string galvanometer. These records reveal a most curious result; the amplitude of the disturbance is always the same (Fig. 9). The only difference between

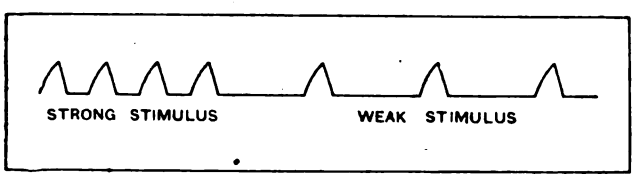

Fig. 9.—A strong or weak stimulus is conveyed by a nerve as a variation in the frequency of the impulses. The amplitude of the disturbance is always the same.

the effects of a strong or a weak stimulus applied to the nerve is that in the former case more pulses are produced in the nerve per second than in the latter. Further, it is found that the passage of a pulse leaves the nerve in a refractory condition for about 0.003 second, during which time no further pulse can pass, so that the nerve can transmit no more than 300 pulses per second. If the nerve passes through a ganglion (a swelling on the nerve which acts as an amplifier of the pulse) the number is still further reduced.

Here, then, a fatal objection arises to the telephone theory: how can a nerve convey the sensation of a note of 20,000 cycles per second when it can transmit but a few hundred pulses per second?

How Our Ears Deceive Us.

When the tuned strings in our ears respond to the throb and pulse of sounds which reach them they may play strange tricks at times: they may actually generate tones, phantom tones, which do not exist save in the ear itself: out of two sounds they may create a third; out of a single sound they may create a multitude.

When a tuning fork gives out its single pure tone we should expect the strings of the basilar membrane to vibrate most strongly near the resonance point, with neighbouring strings affected in rather smaller measure.

The Ear Makes Its Own Overtones.

If in addition we sound a feebler note of different pitch it may be drowned by the louder tone unless its strength is sufficient to cause a subsidiary peak on the main resonance curve (Fig. 13). This drowning, or *masking*, effect might be expected to be greater when the two notes are close together than when they are far apart. Fig. 14 shows results on masking obtained by Fletcher in 1923. He measured the strength of a just audible tone when sounding alone; then he ascertained how many times that strength required to be multiplied for audibility in presence of a second stronger tone. In curve A, Fig. 14, a tone of 800 cycles/sec. was sounded continuously. The ordinates give the multiplying factor required to make any weaker tone audible: the factor is seen to be symmetrical on either side of 800 cycles/sec. with a kink at the maximum due to complications arising from beats when the tones are nearly equal in pitch, and we may conclude that the ear strings vibrate symmetrically on either side of the reson-

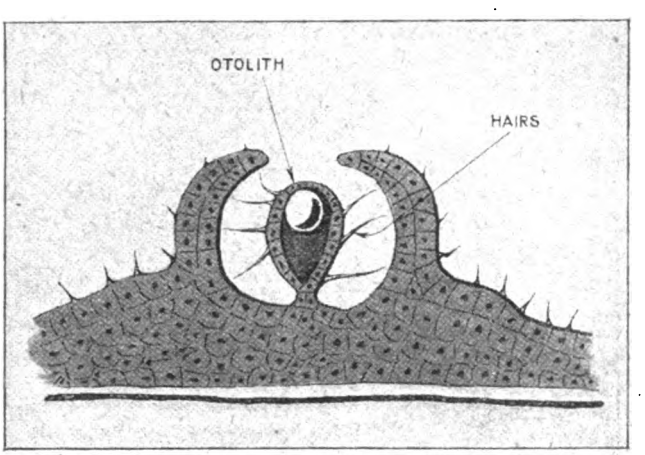

Fig. 10.—While a fish has no powers of hearing, it is equipped with a device that detects violent vibration. It takes the form of a tiny stone which is carried in a sensitive cavity.

ance point as imagined in Fig. 12. But the story changes when the continuous tone is made 4 times as strong (as in curve B), or 8 times as in C. The curve becomes unsymmetrical, the masking is greater on the

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How We Hear.—

high frequency side, and new kinks show the presence of *overtones*, which are harmonics of the 800-cycle note, as is evident since their relative frequencies are as 2, 3, 4, etc.

The Ear is an Unsymmetrical Receiver.

How come these overtones? It is idle to say that they arise in our consciousness or that they are figments of the brain incapable of analysis: science has taught us little if we cannot better such explanations.

A hint is given by the behaviour of vibrating bodies when the amplitude is so large that the strain exceeds the elastic limit or when the load is unsymmetrical, as when a diaphragm is loaded with a wax pellet on one side. Theory shows and experiment agrees that in such cases overtones will appear and will become relatively stronger as the amplitude is increased. Now many unsymmetrical structures occur in the ear: for example, in the arrangement of the muscles which bear on the ear drum, in the ear bones, and in the structures connected to the strings themselves. Hence we have good reason to expect the overtones which Fig. 14 shows to be present. *The ear has the faults of the early microphones used in broadcasting or of a badly designed loud speaker.*

Difference Tones.

But theory goes farther and predicts that when *two* pure tones excite an unsymmetrical receiver a *third* tone will be generated with a frequency equal to the difference between the first two. When the middle C of a piano and the G above, whose frequencies are as 2: 3,

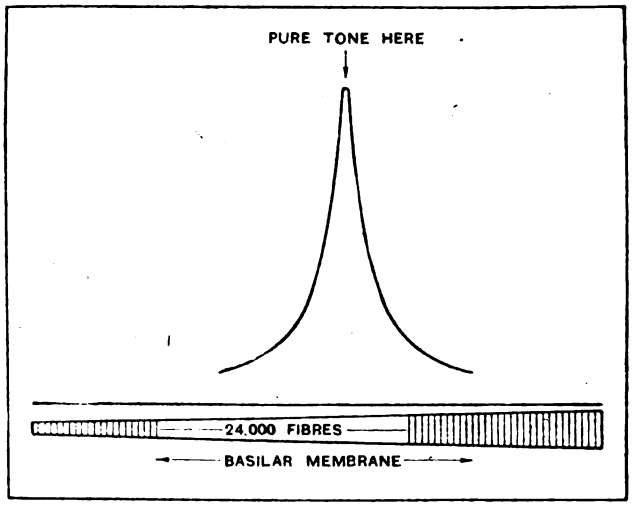

Fig. 12.—Hypothetical amplitude of vibration of the ear strings when a pure tone is sounded.

are sounded together, using the loud pedal, the C an octave below, whose relative frequency is 1, will be heard. We cannot say, however, that this tone is generated only in the ear, for on opening up the piano it will be found that a lower C string is vibrating strongly: the difference tone has been produced by the unsymmetrical frame of the piano. But when the experiment is repeated with tuning forks placed on separate tables with no connection save air, the same difference tone is heard and can be made to give beats with a third fork of nearly the pitch of the difference tone. This tone cannot be picked up by a resonator and so has no existence outside the ear.

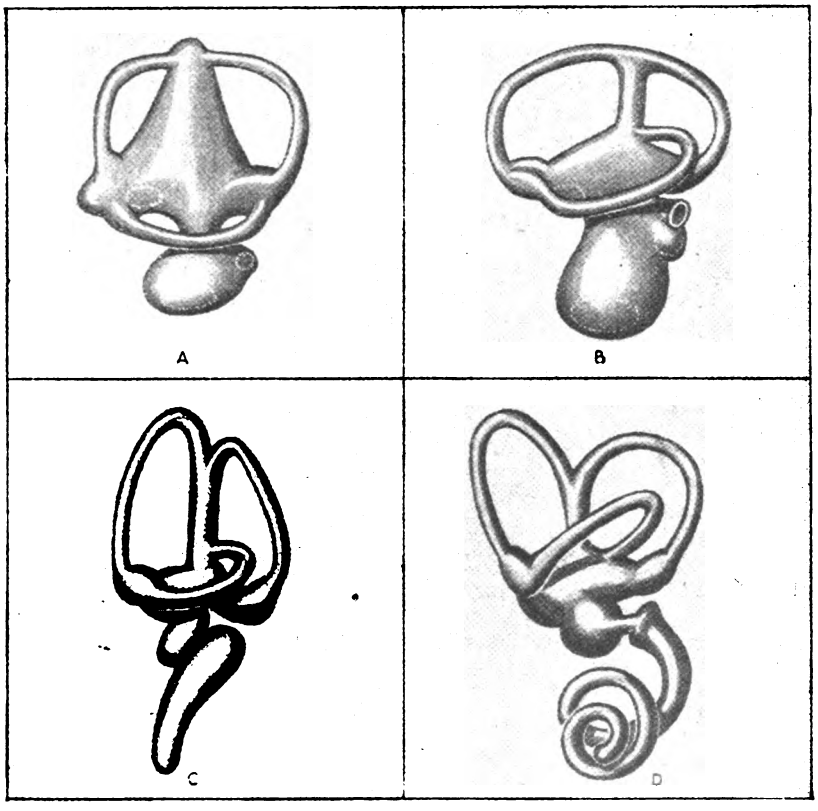

Fig. 11.—The evolution of the cochlea from fish to mammal. A, fish, no cochlea; B, frog, a slight swelling on the right indicates the beginning of the cochlea. C, bird, slightly curved cochlea; D, mammal, spiral cochlea with several turns.

Fundamental Tone Suppressed—No Change in Pitch.

When a vowel is sung, and a record taken on an oscillograph and analysed, the constituents of the complex sound are as shown in Fig. 16: the vowel can be faithfully reproduced by using a series of valve oscillators and loud speakers, one for each partial tone. Now comes a truly remarkable result: if the fundamental tone be suppressed the vowel will sound exactly the same: if in addition the first overtone be silenced the *pitch* on which the vowel is sung will seem unaltered though a very slight change of *quality* will appear, as if the same note had been taken up by a different voice. With

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How We Hear.—

so many overtones present the ear has manufactured the difference tone corresponding to the fundamental with an intensity so great that the presence or absence of that tone in the air makes practically no change, the same being true to a smaller extent of the first overtone.

Does the Loud Speaker Cut-off Matter?

Those who use loud speakers which fail to reproduce below 250 cycles/sec. must have been astonished to hear bass voices, cellos, and bass viols coming through almost unimpaired. The reason is now evident: the low notes, though lost in reception, have been re-created in the ear. We must not conclude that the fundamental tone of *any* sound will reappear, for if the overtones are not harmonic, the difference tone will not coincide with the fundamental: thus drums, cymbals, and xylophones sound unnatural when the lower tones are cut off.

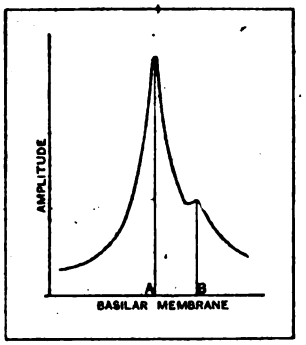

Fig. 13.—A second tone at B is audible if it causes an extra peak on the main resonance curve due to a tone at A.

The Ear is a Rectifier.

The author well remembers how difficult it was fifteen years ago to get the theory of difference tones across the lecture table to second-year students. To-day it is only necessary to give the analogy of the anode bend rectifier and the explanation becomes clear and unforgettable.

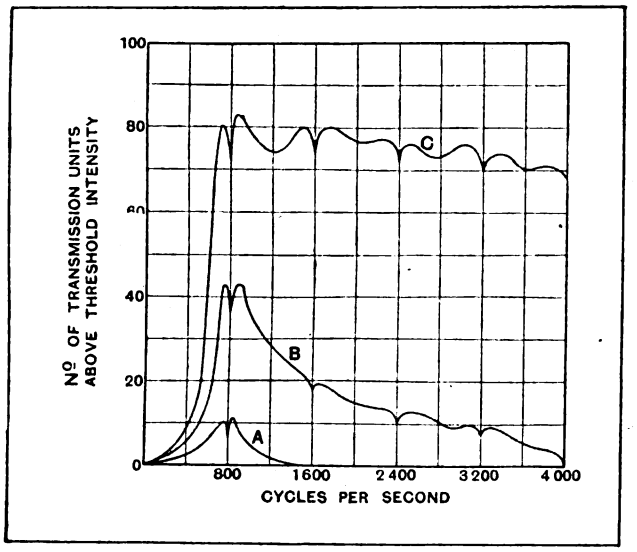

Fig. 14.—Masking of one tone by another: the ear introduces overtones when a note is loud.

For the anode bend rectifier is an unsymmetrical structure. Though the grid voltage may swing up and down by equal amounts the anode current will show unequal changes. When two carrier waves act on the rectifier a heterodyne note (difference tone) is produced: without the rectifier the compound note could only be resolved into its two H.F. constituents and no difference tone would appear. As the carrier waves are made stronger the heterodyne note becomes *relatively* stronger.

The ear gives precisely these results, and the analogy is made closer by the experimental fact that when two notes above the audible range are produced by two bird calls an audible difference tone can be heard, as was shown many years ago by Lord Rayleigh.

Do Beats Merge into a Difference Tone?

Beats are the periodic waxing and waning of sound heard when two pure tones of nearly the same pitch are produced. If the pitch of the higher tone be gradually raised the beats become more rapid and finally pass into a new tone—the difference tone. Whether the beats and the new tone are identical has been a controversial question for fifty years, but on the resonator theory of the ear's action we should say that they are entirely different. Our explanation would be that when, as in Fig. 18, the two tones are close together, the two resonating strings suffer fluctuations of amplitude twenty times per second and that the corresponding nerves carry to the brain information that each string is vibrating with a varying amplitude: at the same time a vibration of twenty cycles per second is produced, but is inaudible because no ear string is tuned to such a low frequency. On raising the pitch of the upper note to 2,100 c.p.s. beats are still heard, but the difference tone of 100 c.p.s. is now picked up by a string and becomes audible as a *tone*: if this string were absent we should hear the beats but not the tone; if the two upper strings were absent we should hear the difference tone but not the beats. Finally if the upper note is raised to 2,500 c.p.s. the beats are so rapid that the nerves cannot convey news of the fluctuations: the beats disappear and the difference tone of 500 c.p.s. is heard alone.

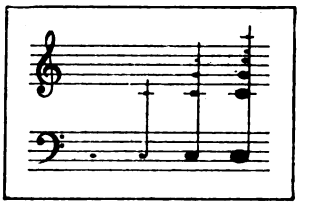

Fig. 15.—Overtones generated in the ear as the bass C is sounded more and more loudly. The sizes of the notes indicate roughly their intensity.

The Sense of Direction.

Familiar sounds like voices, footsteps, or the barking of dogs, can be located without effort: it is easy to say whether they come from front or rear, from right or left. In trying to account for this sense we naturally enquire what happens in the simpler case when the sounds are pure tones such as those produced by a tuning fork.

Suppose a tuning-fork sounding in the middle of a large meadow on a dark night. It is found that if one ear is stopped up an observer has no idea of the position of the fork: if he uses both ears he can easily tell when the fork is on his right or on his left, but he is unable to distinguish a fork in front from one in rear.

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How We Hear.—

Thus we have a clue to the cause of our sense of direction. Sound waves from the fork are diffracted by the head and reach one ear in advance of the other, and so differences of phase and intensity are set up. If the direction of the waves makes an angle A with the fore and aft line of the head we can calculate the phase difference P between the waves arriving at the two ears; in Fig. 19 this relation is shown for tones of different frequencies; thus when we face north and a tone of frequency 310 c.p.s. comes from the north-east the phase will lead by 65° at the right ear.

An Experiment with Headphones.

Now we can try the following experiment: Two telephone magnets are set up, as in Fig. 20, with wires leading from their coils to two ear-phones, and a toothed iron wheel rotates rapidly as shown. A phase difference will be set up between the alternating currents which circulate in the two coils and consequently in the ear-phones; if the phase difference is zero the sound seems

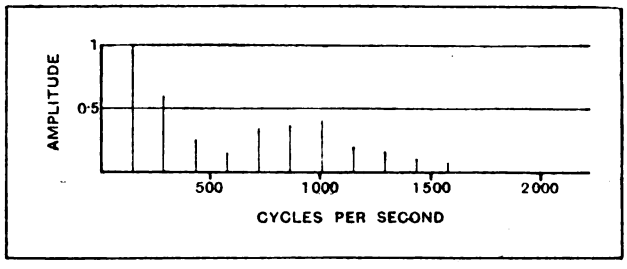

Fig. 16.—Showing the vowel "ah" sung on d.

to come from a point in front, but if the current leads in the right ear-phone the apparent source is displaced to the right through an angle which agrees with that given in Fig. 19. This is a striking confirmation of the theory and so we conclude that the string affected in the right ear leads its opposite number in the left ear in phase, that this lead is preserved in the pulses set up in the pair of corresponding nerve fibres, and that the brain translates this lead into a judgment that the sound is coming from a point to the right of the line of sight.

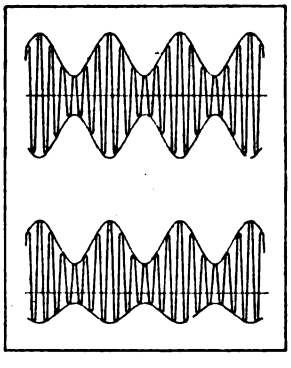

Fig. 17.—Any unsymmetrical receiver will produce partial rectification of a wave: the unsymmetrical structure of the ear must cause a similar effect.

So much for relative phase, but what about the relative intensity at the ears? Experiment shows that relative intensity is comparatively ineffective in helping to form a judgment as to direction. This result leads us into difficulties, for a strong stimulus causes more pulses to travel per second along a nerve, and if the pulse frequencies are unequal in two corresponding nerves no permanent phase difference can be set up.

How, then, do we keep a sense of direction? No doubt the physiologists will eventually supply the answer, but in the meantime we may hazard the guess that the nerve pulses are not continuous but form intermittent trains,

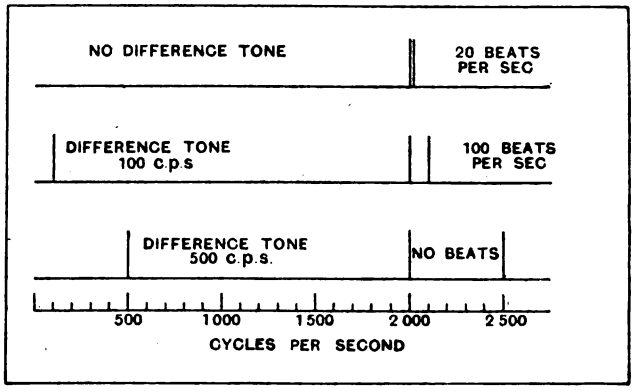

Fig. 18.—How beats merge into a difference tone.

the leading pair of pulses in each train maintaining a constant phase difference; thus the required lead would exist at the beginning of each train, though it would rapidly disappear after a few pulses have passed (Fig. 21).

Multiple Images.

For sounds of high frequency the sound may appear to be in two or more positions at the same time. Thus at 930 c.p.s. let the phase be made to lead by 150° at the right ear; this is the same thing as if the phase were to lead by 360° − 150° = 210° at the left ear. From Fig. 19 we see from the curve corresponding to 930 c.p.s. that phase differences of 150° and 210° corre-

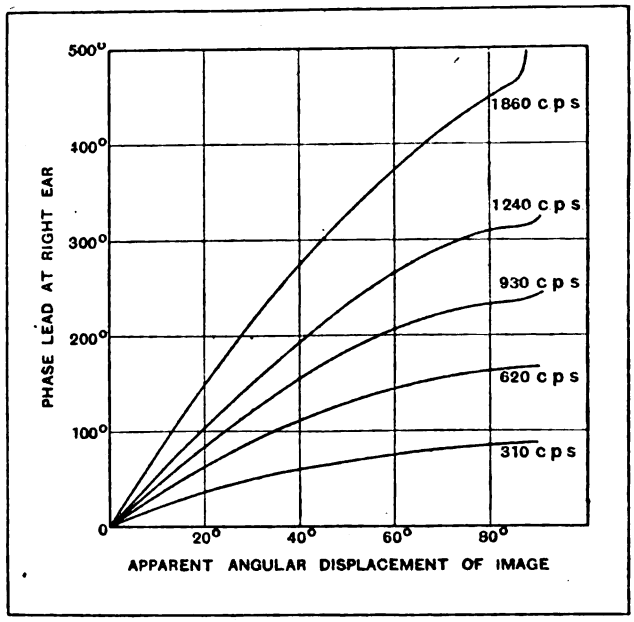

Fig. 19.—The sense of direction of sound depends upon a phase difference between the waves arriving at the two ears. This illustration shows such phase difference for tones of different frequencies.

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How We Hear.—

spond to apparent displacements of the image of 39° to the right and 62° to the left. Obviously the location of the sound is going to be made much more difficult if it seems to come from more than one point, and most observers find that their judgment breaks down for frequencies higher than 1,000 c.p.s.; the chirp of a cricket, for example, seems to come from all directions at once.

The Evolution of Hearing.

We believe that all living beings may trace their descent from the life which began in the warm seas of some thousand million years ago. The fishes of to-day inherit an unbroken tradition of environment over this vast reach of time. What have we discovered about the hearing powers of fishes?

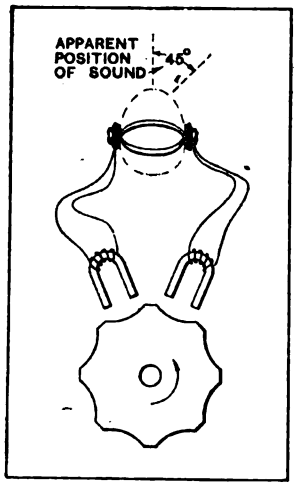

Fig. 20.—This experiment with earphones strikingly confirms the contention that sense of direction depends upon phase difference.

Well, with one or two exceptions, fish seem quite unable to hear. They are indifferent to sounds from a submerged buzzer, loud speaker, or submarine bell. A slight response is shown to violent shocks due to striking the wooden end of a small aquarium by a heavy hammer; this response has been traced to a structure in the head of the fish (shown in Fig. 10) composed of a tiny stone enclosed in a sac which is furnished with hairs. Vibration causes the stone to quiver, and the hairs, striking the sides of the cavity, bend and initiate messages along the nerves attached to them.

The chief purpose of such stones (or otoliths) is to give the direction of gravity, and so enable the fish to swim on an even keel. A certain species of prawn carries its otoliths, not in the head, but in an open cavity in the joint of its antenna, and when the stones drop out the prawn replaces them with grains of sand which it picks up with its forceps. When the prawn was put in an aquarium where iron filings had been placed, it soon became equipped with these magnetic otoliths, and when a magnet was brought near it changed its position as if it mistook the pull of the magnet for the pull of gravity.

As fish emerged from the silent ocean in which their deafness was no handicap, they found new enemies on land, but these were not the noiseless, darting hunters of the deep—their approach was always heralded by sounds, by footsteps, by rustle of reeds or trembling of twigs.

And so the emigrants from the sea began to develop a new sense; the full story is not yet known, but it appears that in amphibia and reptiles like the alligator which never quite forsook the water, and in birds which made the air their own, a tube (Fig. 11) has grown out from the original labyrinth, curved like a sickle, furnished with parallel fibres; in animals which have chosen the dry land this tube has developed into the spiral cochlea, and reaches its highest development among the carnivores and the deer-like tribes, the hunters and the hunted, for whom delicate hearing is a supreme necessity in the daily struggle for existence.

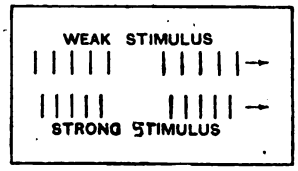

Fig. 21.—Nerve pulses may possibly not be continuous but may take a form of intermittent trains. The leading pair of pulses in each train may maintain a constant phase difference.

CLUB NEWS.

All About Metal Rectifiers.

Mr. S. A. Stevens, of the Technical Department of the Westinghouse Brake and Saxby Signal Co., Ltd., visited the Bec Radio Society on Tuesday, 19th November, lecturing on "Metal Rectifiers" with the aid of an extensive range of lantern slides and the explanatory film which his company have produced.

The lecturer made it clear that the metal rectifier is virtually a cold electronic valve, and an enlarged drawing was shown on the screen giving the manner of assembly of such a unit.

A detailed explanation of the meaning of half-wave and full-wave rectification followed, and an instructive collection of slides included diagrams showing the "centre-tap," "bridge," and "voltage-doubler" methods of obtaining full wave rectification.

The outstanding event of the lecture was the display of the company's film, in which one saw upon the screen living pictures of the performance of alternating and direct currents.

Hon. Secretary, Mr. A. L. Odell, 171, Tranmere Road, S.W.18.

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A Modern Receiver.

An interesting set embodying an indirectly heated A.C. screened grid valve with a magnification factor of 1,200 was demonstrated by Mr. Remington at the last meeting of the South Croydon and District Radio Society. The H.F. amplifier was followed by an anode bend detector, and the last low frequency stage embodied two L.S.5a valves in parallel. The set was operated from the mains. The design was made clear by means of diagrams on the blackboard, members being given full details of the transformers, the design of the moving coil loud speaker, and the wiring arrangements.

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

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New Club's Success.

The recently formed Sevenoaks and District Radio Club is already proving its value to wireless enthusiasts in the district. At the last meeting a powerful set constructed by one of the members was demonstrated. Interesting tests have also been carried out with a radio-gramophone. New members and visitors are cordially invited. Full particulars of the club can be obtained from the Hon. Secretary, Mr E. M. Dent, Cornwall Lodge, Dunton Green, Kent.

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Demonstrating Transmission.

The Muswell Hill and District Radio Society has among its membership no fewer than seven "hams," one of whom, Mr. J. Hum, G5UM, demonstrated his 171-metre transmitter before that Society on December 4th. In order to avoid interfering with broadcast listeners no radiating system was used, but the transmitter was put in an oscillating condition and the wave picked up on a receiver placed on an adjacent table. The lecturer dealt briefly with the principles of crystal control, power supply, and various types of transmitting valve, and then proceeded to show, with the help of the transmitter, the advantages of using crystal control from the point of view of steadiness of wave and purity of note.

Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road, London, N.10.

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Soldering Aluminium.

The soldering of aluminium has always been a *bête noir* to the amateur, but two enthusiasts, Messrs. Hart and Perry, recently demonstrated to members of Wembley Wireless Society that the task can be robbed of its terrors. They also demonstrated brazing, silvering, and ordinary soldering. The Society is at present holding an interesting exhibition of historical wireless apparatus, and the Committee invites members to contribute with any gear which they may believe to have an antique value. The first half of the winter session was concluded on Friday last and meetings will be resumed early in January. An attractive list of fixtures has been arranged. A syllabus of meetings will be forwarded on application to the Hon. Secretary, Mr. H. Comben, 24, Park Lane, Wembley.

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Lecturettes by Club Members.

Several items of unusual interest appear in the forthcoming programme of the Wigan and District Technical College Radio Society, which will resume meetings on January 14th.

An interesting feature includes lecturettes and demonstrations by members themselves.

Hon. Secretary, Mr. M. M. Das, B.Sc., Library Street, Wigan.

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LABORATORY TESTS.

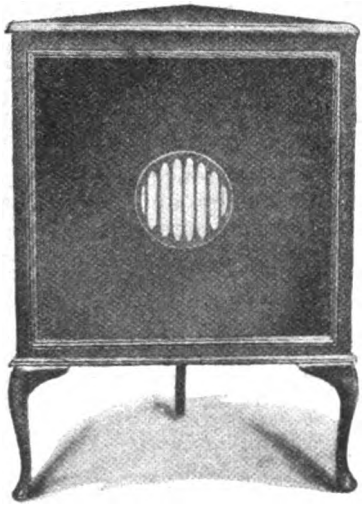
A Review of Manufacturers' Recent Products.

LOUD SPEAKER BAFFLE BOARD.

To obtain the maximum acoustic output from a cone-type loud speaker it is necessary to prevent circulation of the sound waves from the front to the back of the cone. The neutralising effect due to this cause is more devastating on the very low notes than on the higher frequencies. A large baffle board, some 3ft. square, helps to overcome the harmful effect, but, unless well finished, it is rather an eyesore, especially in a drawing room.

Recently the Morogoro Trading Corporation, Ltd., 7, Union Court, Old Broad Street, London, E.C.2, has placed on the market a handsomely finished baffle measuring 30in. × 30in., and mounted on three ornamental legs. The three-cornered design permits standing the baffle crosswise in a corner of the room.

An 8in. diameter opening is provided in the centre of the board, behind which will be mounted the diaphragm and movement. A supporting platform must be made up, but as the nature of this will depend on the chassis used, whether moving-coil or reed-type, the makers have left this to the constructor.



Morogoro three-cornered baffle board for cone loud speaker construction.

The price of the baffle in polished mahogany is 42s., and in oak 38s.

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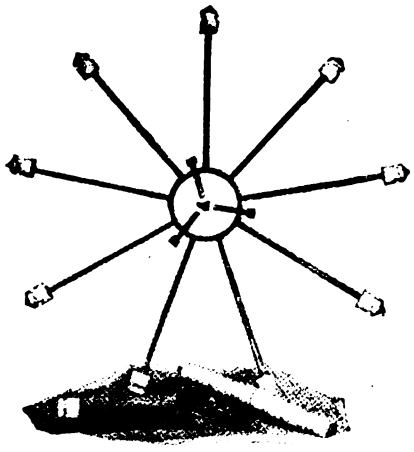
"ASHTON" AERIAL SPREADER. NEW MODEL.

Where facilities are not available for the erection of a suitable sized outdoor aerial of the orthodox pattern, satisfactory reception can be had by using a vertical wire with a cage-type collector at the top. The construction of this alternative device is rendered simple by the new model "Ashton Perfect Aerial Spreader." This consists of two spider-type supports, which are attached to a pole, or iron tube, and spaced about 3ft. apart. They are clamped to the pole by three screwed studs carried on the ring boss of each spider. On the end of each arm is a small porcelain bobbin. The wire is wound in zig-zag fashion, commencing from a top bobbin and finishing at one of the lower ones.

To assure that the device will not sustain damage in the post it is supplied in the form of a set of parts which can be assembled in about fifteen minutes.

The makers are Messrs. Harold Ashton, 8 and 10, Bull's Head Chambers, Hopwood Avenue, Market Place, Manchester, and the price has been fixed at 15s.



One of the spiders, assembled, for the "Ashton Perfect Aerial Spreader"; note the parts for the other.

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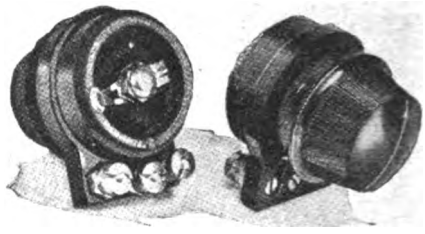
ROTOROHMS.

A wide range of variable high resistances and potentiometers are included in the list of Rotorohms marketed by Rotor Electric, Ltd., 2-3, Upper Rathbone Place, London, W.1. These components, admirably suited for use as volume controls, are available with resistance values ranging from 0 to 2,000 ohms up to 0.1 to 7 megohms. There are eleven models in all, the price being 6s. 6d. for the potentiometer and 5s. 9d. for the variable resistance.

Two specimens were tested, the type H, maximum resistance 25,000 ohms, and the type L, a 500,000 ohms potentiometer. The measured resistance of the first-mentioned model was 36,000 ohms. A graded resistance is adopted, the value changing slowly at first when the knob is rotated in an anti-clockwise direction, but later showing a more rapid rate of change for the same angular movement. This feature is exhibited in the other model. In this case the maximum resistance was found to be 750,000 ohms.

For control of volume, using a potentiometer in the input circuit of a valve, it is desirable that the resistance should change more rapidly at first and those that follow the logarithmic law generally prove most successful. It would appear that Rotorohms have been designed to meet these conditions, so that, used for this purpose, they should prove uniform in action.



The resistance in Rotorohms is protected by a wire-wound track over which the variable contact rides.

TRADE NOTES.

The Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15, announce that their products can now be obtained on the hire-purchase system.

Full particulars of the scheme will be provided on application to the company.

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Lisenin Wireless Co., 5, Central Buildings, High Street, Slough, Bucks.—Descriptive folder dealing with H.T. and L.T. connectors. Insulated plugs and sockets for use in mains-operated sets are listed also.

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Messrs. Ferranti, Ltd., Hollinwood, Lancs.—Descriptive leaflet Wb 419, dealing with the Ferranti Model 31 A.C. mains receiver.

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In the Buyers' Guide 1929-30 list of receiving sets published in our issue of November 20th last, the price of the "Empire 3" receiver made by Messrs. C. F. and H. Burton was stated to include valves and royalties. This is, unfortunately, incorrect; valves and royalties are not included in the prices stated for the two models.

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On page 565 of the same issue the price of the Philips set, Model 2502, should read £12 10s., and not £15, as stated.

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We learn that in some quarters the impression prevails that the "Ekco" Model C.2A. A.C. complete battery eliminator, described on page 537 in our issue of November 13th last, is made for alternating current supplies only. This is, of course, incorrect, as a D.C. unit, also styled Model C.2A., is available for use on D.C. mains. This particular unit was reviewed on page 81 under "Laboratory Tests" in our issue of July 24th last.

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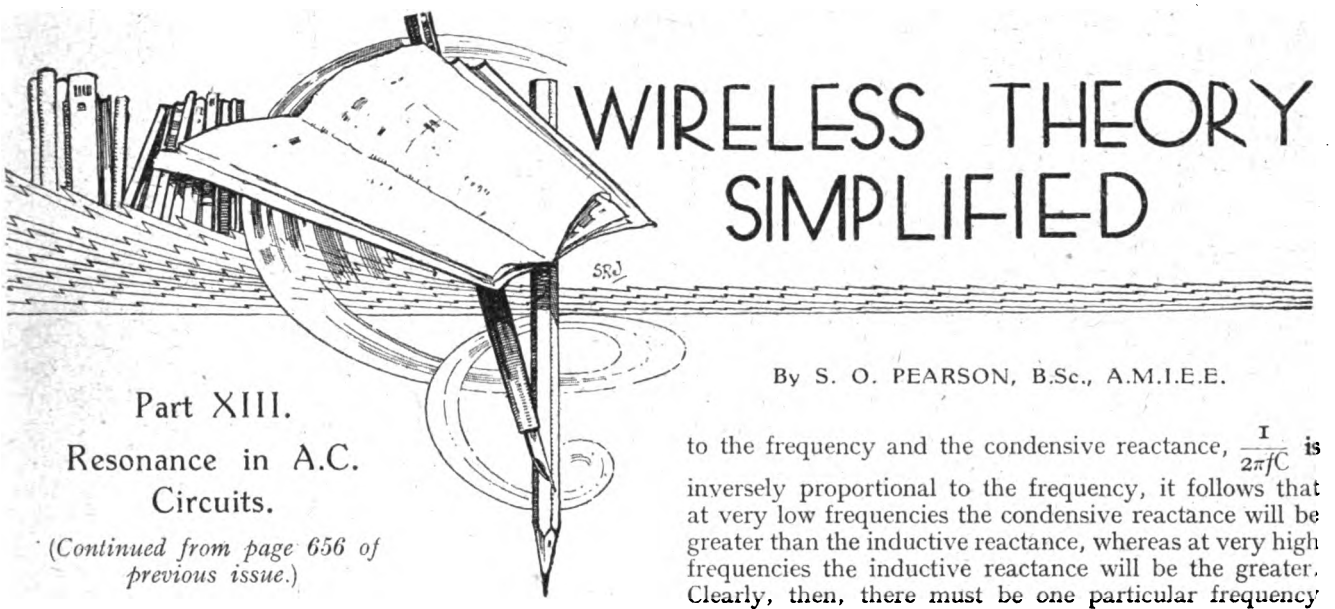

WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

Part XIII.
Resonance in A.C. Circuits.

(*Continued from page 656 of previous issue.*)

AT the end of the previous instalment the impedance was obtained for a simple circuit with resistance inductance and capacity in series. The value of this impedance was found to be $\sqrt{R^2+X^2}$ ohms, where R is the resistance of the circuit and X the resultant reactance, at a frequency f cycles per second, due to the combined effects of inductance and capacity. The value of X itself was found to be $\left(2\pi fL-\frac{1}{2\pi fC}\right)$ ohms, where L is the inductance in henrys and C the capacity in farads. $2\pi fL$ is the inductive reactance and $\frac{1}{2\pi fC}$ the condensive reactance.

Since the resultant reactance X is equal to the *difference* between the inductive and condensive reactances, it is clear that the last two partially neutralise each other if they are unequal, and one will completely neutralise the other if they are equal. When this happens the impedance of the circuit becomes

$$Z=\sqrt{R^2+0}=R \text{ ohms.}$$

That is to say, when $2\pi fL=\frac{1}{2\pi fC}$, the circuit behaves as though it were a non-inductive resistance as far as the relationship between current and voltage is concerned, but in some other respects its behaviour is phenomenal.

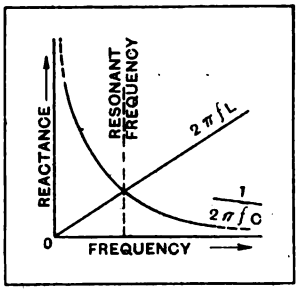

Fig. 1.—Curves showing how the inductive reactance and the condensive reactance vary simultaneously in a series circuit as the frequency is changed.

The value R ohms is obviously the lowest possible value of impedance the circuit can have, because no matter whether the resultant reactance X is positive or negative, the square of this quantity is always positive and therefore always goes to increase the impedance above the value R, or, in other words, the impedance of the circuit can never be less than R ohms.

Frequency of Resonance.

Now since the inductive reactance $2\pi fL$ is proportional to the frequency and the condensive reactance, $\frac{1}{2\pi fC}$ is inversely proportional to the frequency, it follows that at very low frequencies the condensive reactance will be greater than the inductive reactance, whereas at very high frequencies the inductive reactance will be the greater. Clearly, then, there must be one particular frequency for which the reactances will be equal and opposite. This is called the *resonant frequency* of the circuit, and at this frequency the circuit is said to be in complete resonance with the applied frequency. Although the resonant frequency is sometimes called the "natural frequency" of the circuit, this is not strictly correct—a point to be discussed later.

In Fig. 1 the reactance of the coil and that of the condenser are plotted as curves against frequency, ranging upwards from zero. At the point where the curves cross each other the reactances are equal, and this point gives us the value of the resonant frequency. It must be remembered that the condensive reactance is negative with respect to the inductive reactance and, therefore, at the point where the curves cross, the resultant reactance is zero. By finding the difference between the two curves at a number of frequency values we can obtain the curve of resultant reactance against frequency.

Value of the Resonant Frequency.

For the condition of complete resonance we have $2\pi fL=\frac{1}{2\pi fC}$, where f is the resonant frequency, and from this we derive the fundamentally important expression

$$f=\frac{1}{2\pi\sqrt{LC}} \text{ cycles per second}$$

for calculating the resonant frequency, L and C being in henrys and farads respectively.

In tuning a wireless circuit to a given frequency we are simply adjusting the condensive reactance to neutralise completely the reactance of the tuning coil.

Now we must see what is actually happening in a series circuit when a voltage having a frequency equal to the resonant frequency is applied to its ends. The circuit is shown in Fig. 2 (a), and the condition for resonance is that the reactance of the condenser is exactly equal to that of the inductance. Therefore the voltage E_s re-

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Wireless Theory Simplified.—

quired to drive the current against the back E.M.F. of the coil is equal to the voltage E_3 required to drive it "through" the condenser. But since E_2 was seen to lead the current by 90° and E_3 to lag by 90° the two voltages in question are always in direct opposition and so cancel each other out between the ends of the circuit. The complete vector diagram for the condition of resonance is shown in Fig. 2 (b).

Now as the two reactance voltages balance out completely it follows that the applied voltage E between the ends of the circuit is only employed in driving the current through the resistance portion of the circuit. Hence the applied voltage is simply $E = E_1 = IR$. This is in agreement with the previous discovery that the impedance of

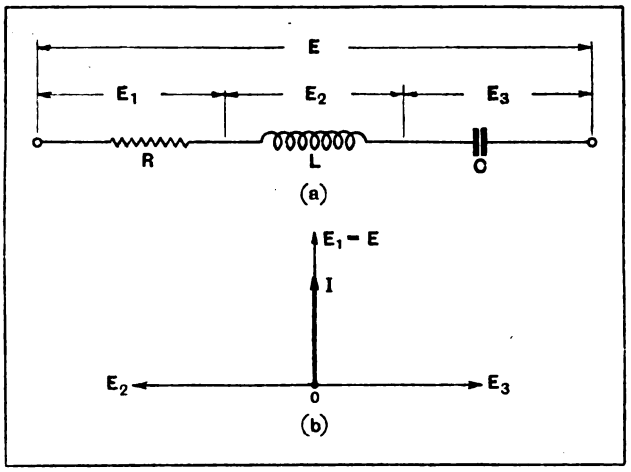

Fig. 2.—When a series circuit is tuned to complete resonance the inductive reactance is wholly neutralised by the condensive reactance. The voltages E_2 and E_1 are equal and opposite, and balance out.

the complete circuit is R ohms at the frequency of resonance. The vector diagram indicates the equally important fact that at this particular frequency the *applied voltage and current are exactly in phase.*

It would seem then that we are driving the current through the two reactances of the circuit in series without the aid of any E.M.F. from the external source. The secret lies in the fact that once the alternating current has been started and has reached a steady R.M.S. value, neither the inductance nor the condenser absorb any power from the source of supply. When the current is falling from one of its maximum values to zero the voltage across the condenser is building up from zero to a maximum and therefore during this time the whole of the stored energy coming from the collapsing magnetic field is being transferred to the condenser and *vice versa*. Hence the stored energy in the circuit is merely oscillating backwards and forwards between the condenser and the coil and no call is made upon the source of supply for assistance. A mechanical analogy for resonance in an A.C. circuit will be given in dealing with the parallel circuit as it can be more simply applied in that case.

Calculation of an Actual Circuit.

As it is very important to know how a resonant circuit behaves not only at the resonant frequency itself but also at neighbouring frequencies, it will be best to consider an actual circuit and calculate the numerical values of impedance and current over a band of frequencies ranging from well below the resonant frequency to well above it, and then to plot the results as curves.

Accordingly let us suppose that we have a coil whose inductance is 2532 microhenrys, that is 2532×10^{-6} henry, in series with a condenser of capacity 0.00025 microfarad. Let the resistance of the coil be 500 ohms. It was pointed out in a previous part that a coil possessing both resistance and inductance is equivalent to a series circuit with resistance and inductance separated. This high value of resistance is chosen to simplify the calculation and the effects of varying the resistance will be discussed afterwards.

The resonant frequency of the circuit will be

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{2532 \times 10^{-6} \times 0.00025 \times 10^{-6}}} = 200{,}000$$

cycles per second or 200 kilocycles per second, and at this frequency the impedance of the circuit will be numerically equal to its resistance, namely 500 ohms, because the reactances balance out.

Now let us calculate the impedance at a frequency just double that of the resonant value, that is, at 400 kilocycles. At this frequency the reactance of the coil will be $X_L = 2\pi fL = 2\pi \times 400{,}000 \times 2532 \times 10^{-6} = 6364$ ohms. The reactance of the condenser is

$$X_c = \frac{1}{2\pi fC} = \frac{10^6}{2\pi \times 400{,}000 \times 0.00025} = 1591 \text{ ohms.}$$

Thus the total reactance of the circuit at 400 kilocycles per second will be $X = X_L - X_c = 6364 - 1591 = 4773$ ohms, and the impedance is therefore

$$Z = \sqrt{R^2 + X^2} = \sqrt{500^2 + 4773^2} = 4803 \text{ ohms.}$$

If we choose a frequency below the resonant value, say 120 kilocycles per second, we find that the condensive reactance is greater than the inductive reactance, so that we get a negative value for the resultant reactance X. It works out to -3394 ohms and the impedance is therefore

$$Z = \sqrt{500^2 + (-3394)^2} = \sqrt{500^2 + 3394^2} = 3432 \text{ ohms.}$$

The impedance is always positive by its very nature.

Frequency-Kilocycles per sec.	$X_L = 2\pi fL$	$X_c = \frac{1}{2\pi fC}$	$X = (X_L - X_c)$	$Z = \sqrt{R^2 + X^2}$	Current $= E/Z$
0	0	∞	∞	∞	0
20	318	31,820	−31,502	31,510	0.317 mA.
40	636	15,910	−15,274	15,284	0.650
80	1,273	7,955	− 6,682	6,692	1.49
120	1,909	5,303	− 3,394	3,432	2.92
160	2,550	3,978	− 1,428	1,512	6.62
200	3,182	3,182	0	500	20.00
240	3,818	2,651	+ 1,167	1,267	7.89
300	4,773	2,121	+ 2,652	2,699	3.70
350	5,568	1,818	+ 3,750	3,785	2.64
400	6,364	1,591	+ 4,773	4,803	2.08

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Wireless Theory Simplified.—

In this manner the impedance of the circuit has been worked out for a number of different frequencies ranging from zero to 400 kilocycles per second and the results are given in full in the table, the values being in ohms.

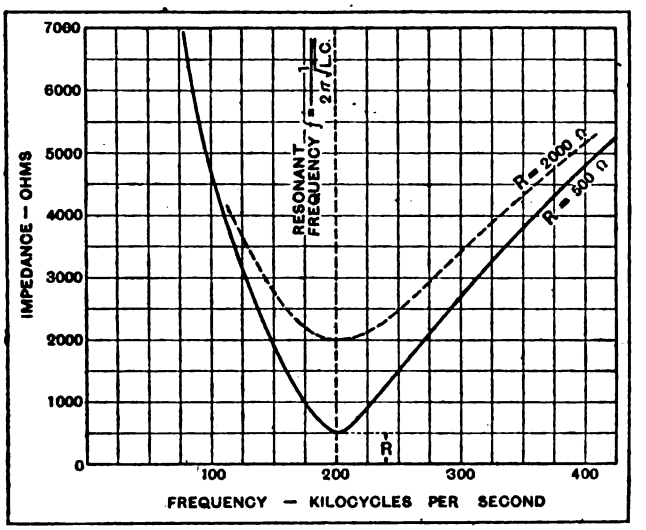

Fig. 3.—Curves showing how the impedance of a series circuit with inductance and capacity varies with frequency. L = 2532 microhenrys, C = 0.00025 μF.

An examination of the table will show that, as the frequency is increased from zero, the inductive reactance X_L rises in value from 0, whereas the condensive reactance X_c starts from an infinitely great value (∞) and falls as the frequency is raised, and further, that the two reactances are equal when the frequency is 200 kilocycles per second (this corresponds to a wavelength of 1500 metres). As regards the impedance of the circuit it will be seen that this has high values at each end of the frequency range chosen and falls to a minimum of 500 ohms at the resonant frequency.

The calculated impedance values given in the table have been plotted as a graph, shown by the full line curve in Fig. 3, to enable the reader to see at a glance how the impedance of a series circuit with inductance and capacity varies with frequency.

It will be observed that at frequencies far removed from the resonant value, the resistance of the circuit has a negligible effect on the value of the impedance—in these cases the impedances are nearly equal to the resultant reactances which are themselves very high. At frequencies very close to the resonant value however, the resistance is the controlling factor and at the resonant frequency itself the resistance is the only thing that counts.

The height of the lowest point of the impedance curve above the frequency axis is equal to the resistance of the circuit and to show the effect of changing the resistance value of the circuit without altering the inductance and capacity, the dotted curve has been included in Fig. 3, giving impedance values when the resistance is 2000 ohms. If the circuit could be imagined to have no resistance at all the impedance curve would actually touch the base line.

Resonance Curves.

In the last column of the table are given the values of current taken by the circuit at the various frequencies, assuming a constant E.M.F. of 10 volts R.M.S. value to be applied to the ends of the circuit. At any one frequency the current is obtained in amperes by dividing 10 volts by the impedance at that frequency, then multiplied by 1000 to give the result in milliamperes.

The values of current so obtained have been plotted as a curve against the frequency in Fig. 4 and from this curve we can judge at a glance the general behaviour of the circuit. The curve shows that as the frequency increases and approaches the resonant value of 200 kilocycles per second, the current increases very gradually at first and then very rapidly for frequencies between 150 and 200 kilocycles per second. It reaches a maximum value of 20 milliamperes at the resonant frequency and then begins to fall rapidly again when the resonant frequency is exceeded.

Selective Effect of Tuned Circuit.

The main feature is that the circuit allows much greater currents to pass if their frequencies are at or near the resonant value than if they have frequencies far removed from the resonant value. The circuit is thus seen to have the property of selecting currents whose frequencies lie within a comparatively narrow band of values in the neighbourhood of the resonant frequency, and of choking back currents whose frequencies are outside this band.

The curve of Fig. 4 is called the *resonance curve* of the circuit, and from its shape and the sharpness of the peak the performance of the circuit can be judged. It should be noted that the peak of the resonance curve has a rounded top; this is so because the impedance of the circuit is equal to the resistance R at the resonant frequency, and any very small change of frequency will only introduce a small amount of unbalanced reactance,

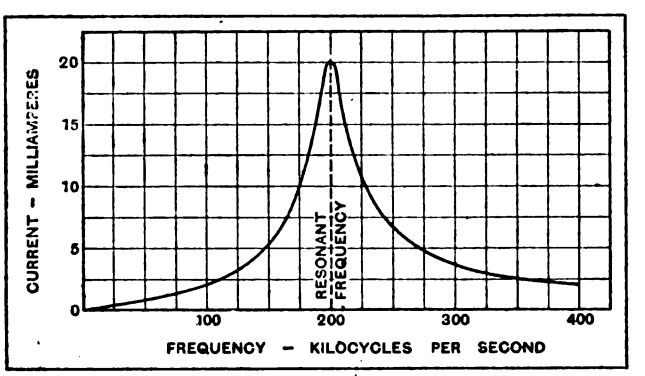

Fig. 4.—Resonance curve for a series tuned circuit where L = 2532 microhenrys, C = 0.00025 mfd. and R = 500 ohms.

negligible with respect to the resistance; and so the current curve must have a horizontal portion just at the top. Another point is that the peak of the curve is not symmetrical in shape.

The degree of selectivity of a tuned circuit and its general efficiency depend upon a number of factors and a discussion of them will constitute the subject of the succeeding instalment.

(To be continued.)

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The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

THE THIRST FOR POWER.

Sir,—As a reader of your paper, and one who has so far been in agreement with its opinions, I must take exception to the leading article, "The Thirst for Power," in the last issue. There are a very large number of wireless listeners in this country who pay their licence fee and yet do not get the type of programme they want. Moreover, here there are very large gaps on Sunday in which no transmission takes place and what is given is severely restricted in type.

Continental stations give programmes all day on Sunday and their week-day evening transmissions give an alternative source of enjoyment in the form of splendid orchestral concerts, operas, etc., to the interminable series of talks, jazz music, chamber music, etc., which we are given here. I venture to say that the ordinary man, when he returns home in the evening and sits down, likes to listen for a couple of hours to an uninterrupted programme of lively music, or a concert, such as are regularly broadcast abroad. At present an efficient three-valver will, with foreign transmitters working on 7 to 20 kW., give good results on a loud speaker. Those who possess more selective and powerful sets—mine is one of your four-valve circuits—get still better results, and I find stations like Turin, Vienna, Brateslava, etc., come through as well as, and generally better than, 5GB. Now, sir, when more powerful stations are working, such as Rome and Oslo soon will be, on 50 kW., they will give L.S. results in this country, judging from my experience, practically as good as 2LO. Listeners here, therefore, who have to go abroad for their entertainment owing to the restricted and classical type of programme that is given will in no way feel alarmed, but will welcome such increase of power. I am unable to understand why your correspondent, A. W. Scott, gets such "mushy" results. I can assure him that there are at least ten foreign stations, including those I have mentioned, which I receive regularly every evening at tremendous strength on a M.-C. speaker. They drown out all mush, Morse and background noise. Fading is, of course, sometimes present, but increased power will minimise this and present better reception for the weaker set. I trust you will find space to publish this letter as I am sure many thousands of listeners hold these views. J. CHANDLER.

Upminster, Essex.

FOREIGN STATION RECEPTION.

Sir,—I deeply sympathise with Mr. A. W. Scott, of Chipstead, Surrey. He must, indeed, have been bitterly disappointed, after having gone to the trouble and expense of making a "reasonably up-to-date" set of "your own excellent design," to find that all he can receive of the ten to fifteen foreign stations which are available almost any night is a mixture of "transmission *plus* atmospherics *plus* heterodynes *plus* fading *plus* Morse."

I am very sorry for him; but I do consider that he is unreasonable in supposing that the majority of other listeners (more than 99 per cent. of them, in fact) can get no better results than he can.

Surely Mr. Scott must be almost unique if he experiences troublesome fading on the long waveband; and surely if his neighbours are as relentless with their oscillating as to heterodyne continuously all his fifteen stations, his best course would be to send an appeal to the Postmaster-General.

My own experience of foreign reception is admittedly far less disturbing to the nerves. No doubt it is not advisable to amplify foreign programmes to concert-room loudness: to reproduce them with powerful moving-coil speakers; but for all that there are, even in London, a large number which can be received and which can be enjoyed. Not every one every night, it is true, but there is rarely a night on which more than one cannot be well heard.

On a four-valve portable set of a well-designed (and, admittedly, rather expensive) type I can usually get conveniently enjoyable reception from Huizen, from Radio Paris, from Warsaw, from Motala, from Kalundborg, from Hilversum (on its long wavelength), or from Konigswusterhausen on the long waveband; and from Budapest and Vienna (though sometimes entangled with Morse), Berlin, Frankfurt, Toulouse, Breslau, and many others on the shorter waves.

I find that in the country (unless near the sea) I can get many more.

I may add in conclusion, in case Mr. Scott should think that my standards of reproduction are perverted, that for local reception of the London programme I use a very carefully designed set, employing in the last stage two L.S.5A valves, running on 300 volts, and feeding a well-made moving-coil speaker. C. K. HERBERT.

London, S.W.1.

Sir,—I read with interest the letter of Mr. A. W. Scott (27/11/29) criticising your attitude to the Regional Scheme, and as my own experiences of "foreign listening" are similar to his I fully endorse his views.

Situated three miles N.E. of Glasgow, I can pick up most of the leading European stations at loud-speaker strength, but after three years of "foreign listening" I have decided that distance and quality seldom go together, for reception is more than often marred by statios on the long waves and fading and heterodyning on the short waves. In fact, I could easily count the number of nights on which a "distant programme" was received without some kind of extraneous Morse or interference. Even 5XX is not free from static on some occasions, and although the volume and quality of Brookmans Park are good there is periodic fading.

So the local station only remains, and even it is not above reproach, for about 80 per cent. of the programme comes over 400 miles of land-line before being transmitted. So until Scotland has its own regional station, and one transmission does not require the assistance of the land-line, then only can we hope to have first-class quality.

So may the regional station for Scotland materialise and the scheme prosper. K. M. TOPPING.

Glasgow.

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Broadcast Brevities

By Our Special Correspondent.

Listeners' Reports on Twin Transmissions.—Mains Sets for Schools.—Money and Music.

Listeners and the Twin Transmitters.

Mr. Noel Ashbridge, the B.B.C.'s Chief Engineer, is agreeably surprised at the number of listeners who have taken the trouble to report favourably on the twin transmissions from Brookmans Park. Profiting by earlier experience, however, he refuses to be beguiled by the first batch of letters. Those who first take up the pen are the enthusiasts—the people who have good sets; the smaller fry who have only a hazy notion of what the scheme is all about are probably just discovering that additional selectivity is now necessary.

oooo

Erratic Modulation.

From my own experience I would say that it will be easier to judge how comfortably the two stations can be separated when the 261-metre transmitter settles down to a fairly uniform output. Modulation appears to be erratic and there are times during the late dance music when the new transmitter suddenly spreads itself out in a manner which must cause pain to many listeners living within 5 miles of Brookmans Park.

However, it is too early to criticise. Who knows what a week may bring forth?

oooo

L.C.C. and School Wireless.

"Mains Sets for Schools" seems to be the new slogan of the London County Council. I hear that the question of school sets appeared on the agenda at last week's meeting of the Council, following upon an inspection in several schools where battery-operated receivers were proving costly and difficult to maintain.

As an indication of the importance which the L.C.C. attaches to broadcast lessons it is significant that steps are to be taken to ensure that only the best and latest design of receivers are to be used for the work, with power supply from the electric mains.

oooo

School Sets Need Supervision.

According to the B.B.C. at least 3,000 schools up and down the country are known to be taking one or more of the broadcast courses. Little information is forthcoming regarding the type of quality of the sets employed, though the B.B.C. engineers undertake to inspect sets and give advice when requested to do so. Is this good enough? Some responsible authority should surely be commissioned to see that scholars are ensured decent, distortionless reception. The schoolmaster entrusted with the management of a class cannot be expected to pay attention to grid bias and H.T. battery voltage at the same time.

The L.C.C. is acting wisely in the matter, and it is to be hoped that other educational authorities will also tackle the question.

oooo

The "Early to Bed" Station.

Two main programmes nightly in watertight compartments will be the principle adopted by 2LO, 5GB and other stations early in the New Year.

Beginning on January 6th, 5GB will start its first programme at 6.30 p.m. and its second at 8.35, and a noteworthy feature will be the introduction of a nightly talk at 8 o'clock—the first serious attempt to introduce talks from the experimental station. The station will close down at 10.30 each evening.

oooo

Original Programmes from Regional Twin?

2LO, 5XX and other stations will start their two main programmes at 7.45 and 9.45 respectively Comparing these times with those of 5GB, it will be seen that the experimental station will provide light relief during the 7 to 7.45 talks period from the other stations

What of the programme from the twin station at Brookmans Park? I am asked to understand that an *original* programme will be provided, but I retain the belief that the provincial stations may help to contribute.

CHRISTMAS PROGRAMME FEATURES.

London and Daventry (5XX).

DECEMBER 23RD.—Nativity play relayed from St. Hilary's Church, Cornwall—"Bethlehem," by Bernard Walke.

DECEMBER 24TH.—Carols relayed from St. Mary's, Whitechapel.

DECEMBER 25TH.—"Cox and Box," comic opera, by Burnand and Sullivan.

DECEMBER 26TH.—"Cinderella," a pantomime, by Ernest Longstaffe.

DECEMBER 28TH.—"Rupert of Hentzau," a play by Anthony Hope.

Daventry Experimental (5GB).

DECEMBER 24TH.—Light orchestral programme and solos.

DECEMBER 25TH.—"Cinderella," a phantom pantomime, by Ernest Longstaffe.

DECEMBER 26TH.—"The Messiah" (Handel).

DECEMBER 27TH.—"Rupert of Hentzau," a play by Anthony Hope.

Cardiff.

DECEMBER 23RD.—Carols relayed from the Exchange, Cardiff.

DECEMBER 27TH.—"A Visitor for Christmas," a Yuletide playlet, by F. Morton Howard.

Manchester.

DECEMBER 24TH.—"Christmas Eve at Browns," by Edwin Lewis.

DECEMBER 25TH.—Christmastide request orchestral programme and songs.

Glasgow.

DECEMBER 24TH.—"No Room at the Inn," a Christmas morality play, by David Cleghorn Thomson.

DECEMBER 27TH.—Tullytassie Hogmanay Gathering—grand soiree and concert, followed by an assembly in the Burgh Hall, Tullytassie.

Belfast.

DECEMBER 24TH.—"Christmas Eve in Ballinulcaghey."

oooo

The European Network.

A step forward towards that European relay network to which reference was made recently is indicated by the news that the B.B.C. now prepares a list of attractive musical features to be broadcast six weeks ahead. This list is sent to broadcasting authorities in Germany and Belgium, i.e., countries in which the land lines are favourable for musical transmission. I understand that the courtesy is reciprocated.

oooo

Matters Musical.

Dr. Adrian Boult's appointment as musical director of the B.B.C. is to be deferred until May 15th next. This will enable Mr. Percy Pitt, the present holder of the post, to prove that an artist's powers of expression do not frizzle up immediately their possessor attains the age on which the B.B.C. sets the seal of superannuation.

oooo

An Expensive Orchestra.

Meanwhile the future of Sir Thomas Beecham's "National Orchestra" is coming up for discussion. It is an open question whether this experimental combination which Sir Thomas is conducting will become a permanent institution, as was suggested during its formation, although no changes are likely before next autumn. In the interval, of course, the B.B.C. is faced with its liabilities in regard to a number of the players who will be drawing anything between £15 and £25 per week from Savoy Hill for the next three years.

In view of this expenditure of listeners' money, the public will want to hear a good deal more of the orchestra between now and 1932.

oooo

The Truth.

"The Truth About the B.B.C." was the striking title of an article published a few days ago. Some doubt is expressed as to whether this is the 254th or the 255th time that this striking title has been employed.

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READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Moving the Reaction Condenser.

My detector—2 L.F. set—would be quite satisfactory were it not for the fact that hand capacity effects are troublesome when operating the reaction condenser. I am told that this is because the condenser is connected in such a way that both its moving and fixed vanes are at high potential; this seems to be correct, as an experimental reversal of connections does not have any noticeable effect.

I am sending you a circuit diagram of the receiver. Will you please tell me if there is any easy way of overcoming the difficulty?

G. P. S.

Your diagram (of which the part in question is reproduced in Fig. 1) shows that the reaction condenser is connected between the detector valve anode and the high-potential end of the reaction coil: in this position hand capacity effects are likely to be evident, particularly if the condenser is unscreened, and if its operating knob is of such dimensions that the operator's hand comes into close proximity to the "live" spindle.

We suggest that the condenser should be moved to the position indicated by "X" in the diagram, the existing connections being, of course, joined together. Although this sounds easy enough, it may possibly be necessary to rebuild the coils if interchangeable plug-in inductances are fitted, or, alternatively, if waveband switching is used, to elaborate the switch change-over connections. This is because an extra connection must be led out from the coil assembly to enable you to work with an "earthed" reaction condenser.

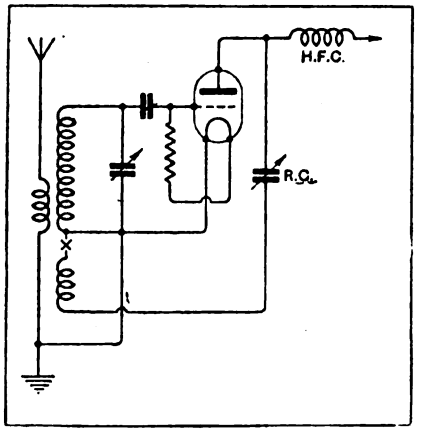

Fig. 1.—Hand capacity effects in a regenerative detector valve circuit may generally be overcome by transferring the reaction control condenser to the position marked X.

o o o o

Modified "A.C.2."

My "A.C.2" receiver, as described in "The Wireless World" for August 22nd, 1928, was sufficiently selective until the new 2LO started working; now I find that this station tends to "spread" very seriously unless a value of series aerial-condenser sufficiently small to cause considerable diminution of signal strength is inserted. Would it not be possible to alter the tuned circuits of this receiver to conform with the arrangement included in the "Two-Circuit Two" ("The Wireless World," February 6th, 1929)? It is realised that the cathodes and heaters will be connected in the conventional manner; is any other alteration necessary, and do you anticipate that any difficulty will be encountered? W. R. N.

There is no reason why your proposed alteration should not be effected, and no alterations other than the obvious ones will be necessary. Due to the high efficiency of the detector valve as compared with battery-heated types, there will be an increased tendency towards self-oscillation, but this can be overcome by suitably setting the relative values of the reaction feed condenser and the reaction control condenser.

o o o o

Simple Pick-up Connection.

I believe that it is possible to convert the "Everyman Four" for gramophone reproduction simply by connecting a pick-up by means of a length of flex to an ordinary coil plug, and inserting this plug in the socket normally occupied by the long-wave loading coil. Please tell me if this is correct.

J. le G. L.

The answer to this question depends on whether it relates to the original "Everyman Four" or to the model with potentiometer control of detector grid bias, as described in the last edition of the "Everyman Four" booklet.

It is quite in order to connect a pick-up to the modified receiver in the manner that you describe, but some form of volume control will be required; this should not be "later" in the chain of amplification than in the grid circuit of the first L.F. valve. Of course, the value of negative bias normally applied to the detector must be reduced when this valve is made to function as an amplifier; this is easily done by giving a partial turn to the potentiometer knob.

o o o o

Two Eliminators.

I am about to rebuild my receiver, and intend to add a push-pull output stage requiring much more energy than can be supplied by my existing eliminator, which is quite satisfactory except only in the matter of power output.

In order to save trouble and expense, it is proposed to use the original eliminator for feeding the H.F. valve, detector, and first-stage L.F. amplifier, and to build a new power unit for the output valves only. Is there likely to be any unforeseen difficulty in doing this? Current is A.C. at 250 volts. G. D.

There is no reason whatsoever why this plan should not be adopted successfully. It can only be criticised on the grounds that it involves the upkeep of two separate rectifiers; in all probability there would be sufficient surplus output from the proposed new power unit to feed the earlier stages of the receiver.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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(17th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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A MINISTRY OF BROADCASTING.

IN the House of Commons some days ago a Member drew the attention of the Speaker to the fact that when he handed in a question complaining of the broadcasting service in the East of Scotland he was informed that there was no department to which he could address it, nor could he address it to the Prime Minister. He asked how the grievance of people who by law paid 10s. a year for receiving instruments could be ventilated. The Speaker said that it was one of the rules governing questions that they must be put to a Minister on subjects for which Ministers had some responsibility. In the matter of broadcasting he understood there was no such Minister. The Postmaster-General stated that he understood that in the matter of broadcasting the Post Office had a responsibility for questions of general policy but no responsibility for questions in detail. Sir W. Mitchell-Thomson, Postmaster-General in the late Government, stated that he had always refused to answer questions relative to broadcasting on particular details as not being himself responsible.

As long ago as November 24th, 1926, writing in *The Wireless World* at the time that publication was given to the new Charter for the Broadcasting Corporation, we chose "A Ministry of Broadcasting" as the title for our leaderette, and, after commenting on the scope of the Charter and referring to the importance with which the subject of broadcasting was treated in a debate in the House of Commons, we concluded by saying "This brings us to the question of how long the Broadcasting Service will remain under the thumb, so to speak, of the Postmaster-General. Probably it will always be necessary for the Service to obtain its licence to operate the stations from the Postmaster-General, but it seems that at a comparatively early date all justification for the Postmaster-General to have authority in other directions will have disappeared, and, to judge by the ever-growing national importance of the Broadcasting Service, it seems to us highly probable that in the not far distant future the appointment of a Ministry of Broadcasting will be regarded as just as essential as other Ministries which have been created to control various other activities of a national character."

If in 1926 there was sufficient evidence to suggest a good case for the formation of a Ministry of Broadcasting, how much stronger a case could be put forward to-day! Had broadcasting in this country remained as in America, largely in the hands of private enterprise, then there would have been no occasion for considering such a step, any more than it could be justified in this country in connection with the Press; but seeing that our national broadcasting service is firmly established under Government control, and taking into account its importance as a national influence, it seems incongruous that this organisation should be without a spokesman in the House of Commons.

oooo

OBITUARY.

OUR readers will have learned, with sorrow, of the loss of one of the greatest of our pioneers of practical wireless telegraphy through the death of Admiral Sir Henry Jackson. Admiral Jackson's career has been a long record of service to his country, and his personality had endeared him to everyone who came in contact with him.

Elsewhere in this issue we record some of the activities of Admiral Jackson's career, which will ensure for him undying recognition in the annals of British history.

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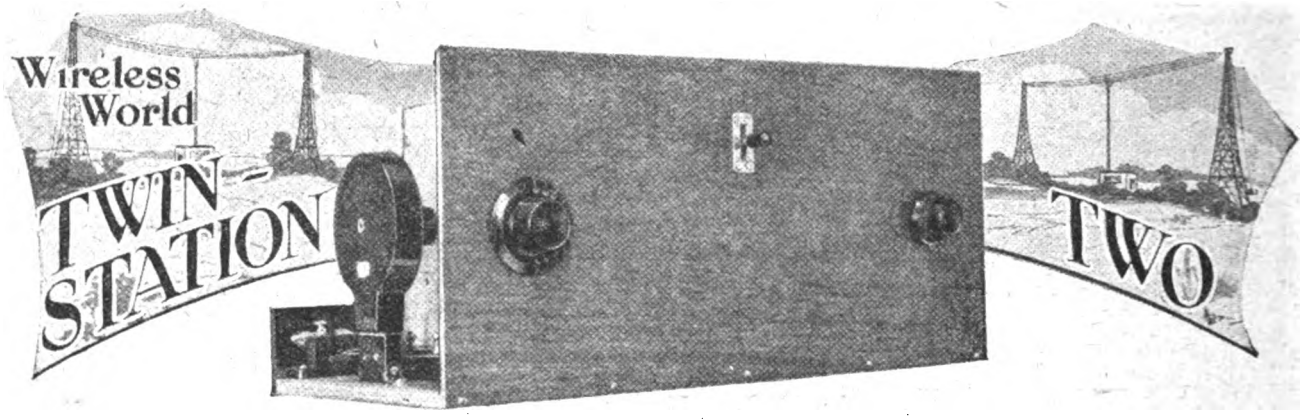

Alternative Programmes Without Retuning.

By H. F. SMITH.

CONTRIBUTORS to these pages have more than once put forward the suggestion that we are all inclined to expect rather too much of our radio receivers, and have hinted that in many cases more enduring satisfaction would result from the use of a set designed for a definite and strictly limited performance under a fairly rigidly defined set of conditions.

It would be futile to suggest that such a rule should be universally applied, and that, having decided exactly what programmes we want to hear, we should design, have designed, or buy ready-made a receiver capable of satisfying these requirements—no more or no less—in our own particular locality. Except in special cases it would be technically impossible to do so.

Although the general-purpose set is perfectly satisfactory for average requirements and localities, there is at least one body of wireless users who should seriously consider the use of a specialised type of receiver. Under this category are included those who live within a few miles of Brookmans Park (or, of course, of any similar twin regional station that may be built). These unfortunate people—or perhaps fortunate; everything depends on one's point of view—will need, for anything like satisfactory distant listening, a highly selective and ambitious receiver—so ambitious that to use it merely for local reception would savour of cracking nuts with a steam-hammer. They will probably either satisfy themselves with local programmes only, or will have two separate receivers, one of which will be designed exclusively for long-distance work.

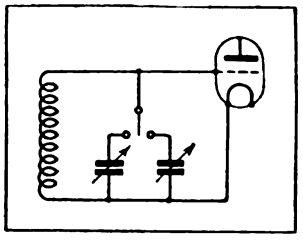

Fig. 2.—Another method of wave switching.

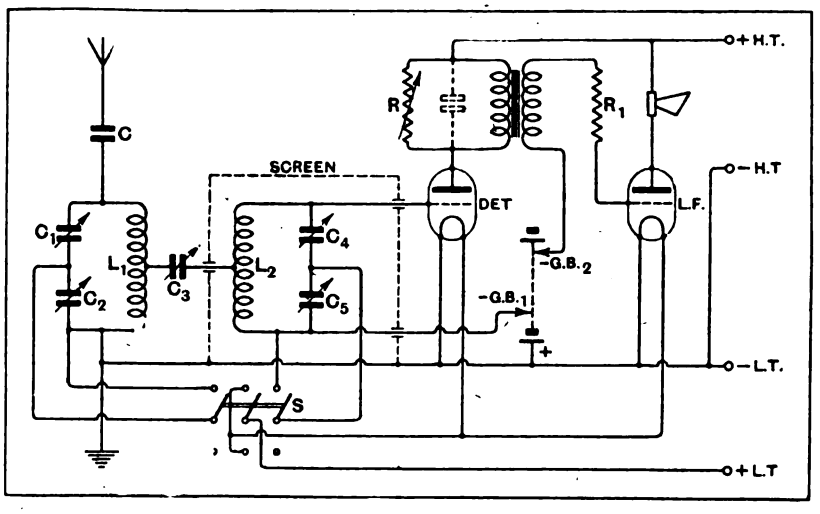

Fig. 1.—Complete circuit diagram. The condenser shown in dotted lines is built into the L.F. transformer. C, aerial shortening condenser, 0.0002 mfd.; C_1, C_2, C_3, C_4, tuning condensers, min. 0.0002 mfd., max., 0.001 mfd. (depending on wavelength); C_5, coupling condenser, 0.0001 mfd. L_1, plug-in aerial coil; L_2, secondary coil (see text); R, volume control resistance; R_1, H.F. stopping resistance, 100,000 ohms. S, combined wave-changing and on-off switch.

Quick-change Reception.

If either of these courses is decided upon it will be readily agreed that the local-station set should be as simple in construction and operation as is possible, and, to avoid the need for constant retuning, a quick and easy change-over from one alternative programme station to the other is clearly desirable. The receiver to be described in this article represents one of the many ways in which these features may be combined in a satisfactory manner. As it is intended for use in a strictly restricted area, it follows that the design as it stands will be suitable for an equally restricted number of readers, but it is hoped that those living outside this area who are interested in the undoubtedly attractive feature of quick-change, programme-to-programme switching will be able to glean some suggestions applicable

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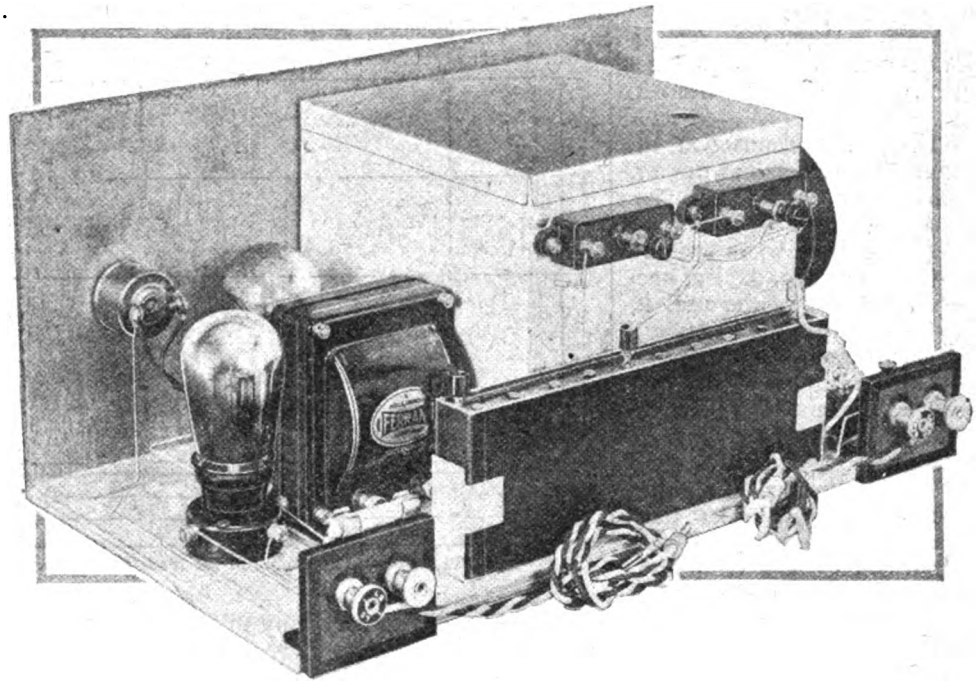
Twin-station Two.—



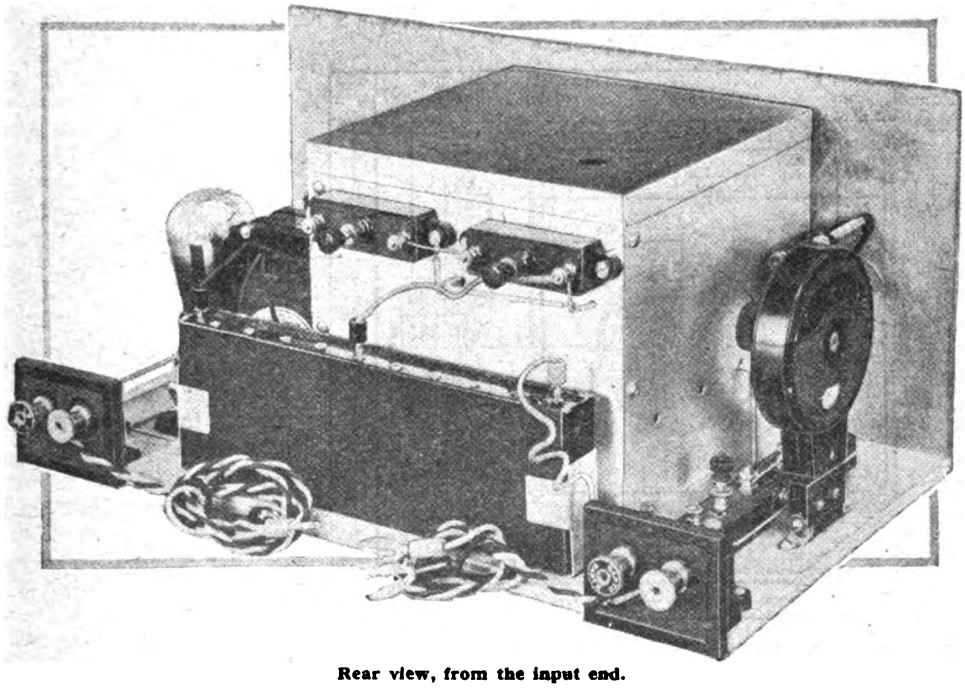
Rear view, from the output end.

to their own needs and geographical situation.

When it is said that the basic circuit diagram comprises an anode-bend detector without reaction, transformer-coupled to an output valve, it will be realised that the set is most distinctly not for long-range work, or even for medium distances. This point should be emphasised, as there is nothing more unsatisfactory than a receiver without sufficient sensitivity—one should say a reserve of sensitivity—for the purpose it is intended to serve. The set gives good results only where signals are really strong: sufficiently strong, say, for a crystal set to operate headphones loudly enough to be audible several inches away from the ear. Of course, the aerial plays its part, and its effectiveness must be increased as we move farther away from the transmitting station.

In order that adequate selectivity for any locality may be obtained, a two-circuit aerial tuner is provided, with variable capacity coupling which serves both as a pre-detection volume regulator and selectivity control. From the circuit diagram given in Fig. 1 it will be seen that the coupling condenser C_3 is connected between the centre points of aerial and grid coils; adequate linkage of the circuits is obtained by these means with a condenser of standard capacity range, and the disturbing effects of coupling changes are less evident than when it occupies the usual position between the high-potential ends of the coils.

The connection of the tuning capacities C_1, C_2, and C_4, C_5, together with the wave-changing switch, may at first appear complicated, but the matter is really quite simple if it is realised that a pair of semi-variable condensers are joined across each circuit, and that one unit of each pair is short-circuited when it is desired to receive the longer of the two twin-station wavelengths. The shorter wave is tuned-in by opening the short-circuiting switches and, without disturbing the settings already obtained, adjusting the remaining condensers. Having once found the right values, programme selection should be merely a matter of throwing the switch to the appropriate position: one condenser of each pair short-circuited for longer wave and both in series for shorter wave. The centre pole of the switch breaks



Rear view, from the input end.

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Twin-station Two.—

the filament supply circuit when in the intermediate position, and so switches off the set.

This series connection of tuning condensers has one or two minor advantages, as compared with the alternative method of wave switching shown in Fig. 2. For one reason, it allows the use, if necessary, of the simplest single pole on-off switches.

The remainder of the circuit arrangement is so simple and conventional that it calls for little comment. The grid coil L_2 is screened in an aluminium box in order that coupling between it and the aerial coil L_1 may be almost entirely through the intermediary of the condenser C_3, and consequently under proper control. A post-detection volume regulation may seem rather superfluous in a two-valve set, but it was considered best to fit a variable resistance across the transformer primary, as overloading of the ordinary power valve will set in before the detector grid circuit is fully loaded. An H.F. stopping resistance R_1 is inserted in series with the output valve grid.

Regarding details of construction, it will be seen that the semi-variable condensers C_4 and C_5, which tune the secondary or grid circuit, are mounted on the back of the screening case. Holes coinciding with their control knobs, and of from $\frac{3}{8}$in. to $\frac{1}{2}$in. diameter, should be drilled through the back of the containing cabinet so that a screwdriver may be inserted for initial adjustment or at any subsequent time if necessary. The remaining tuning condensers are on the baseboard, and are also set with the help of a screwdriver.

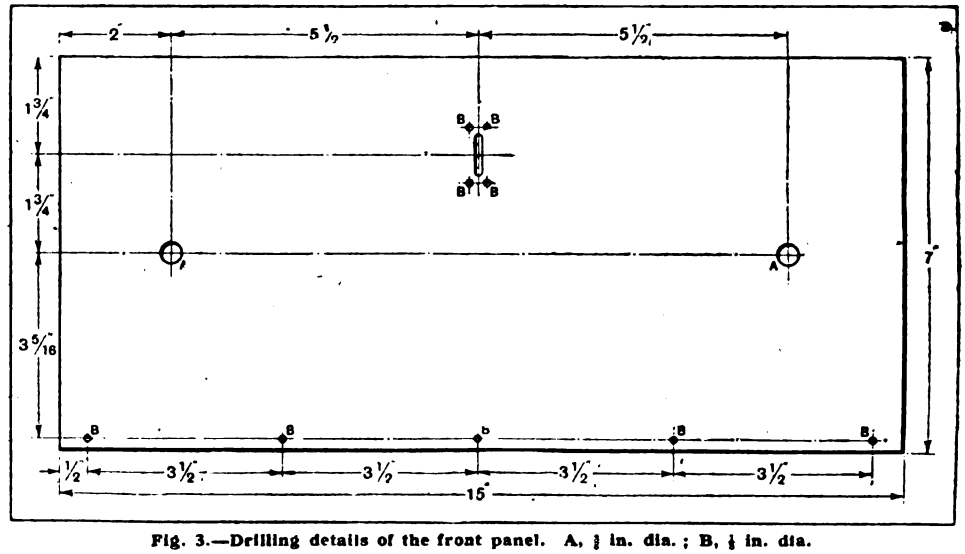

Fig. 3.—Drilling details of the front panel. A, $\frac{1}{4}$ in. dia.; B, $\frac{1}{8}$ in. dia.

Coil-winding Details.

The plywood front panel carries H.F. input and L.F. output volume controls, and a combined on-off and wave-changing switch. In order that the lid of the screening box may be removed when required, it is necessary that the box itself be set back about $\frac{1}{16}$in. to $\frac{1}{8}$in. from the rear surface of the panel by interposing a distance piece in the form of a thin strip of wood, ebonite, fibre, or some similar material; the switch lever and securing screws are passed through this strip.

For the aerial circuit a centre-tapped plug-in No. 40 coil is used, as shown, while the secondary inductance L_2 is a simple, home-made coil consisting of fifty turns of No. 24 D.C.C. on a Pirtoid former measuring $3\frac{1}{2}$in. long by 3in. in diameter. A tapping is brought out from the centre point (25th turn). The winding should be started about $\frac{1}{2}$in. from the upper end of the tube, the lower end of which is secured to the wooden subbase of the screening box with the help of a wooden disc or in any other convenient manner.

"Junit" terminal blocks, screwed to the rear edge of the baseboard in the manner shown, carry terminals for aerial, earth and loud speaker, while

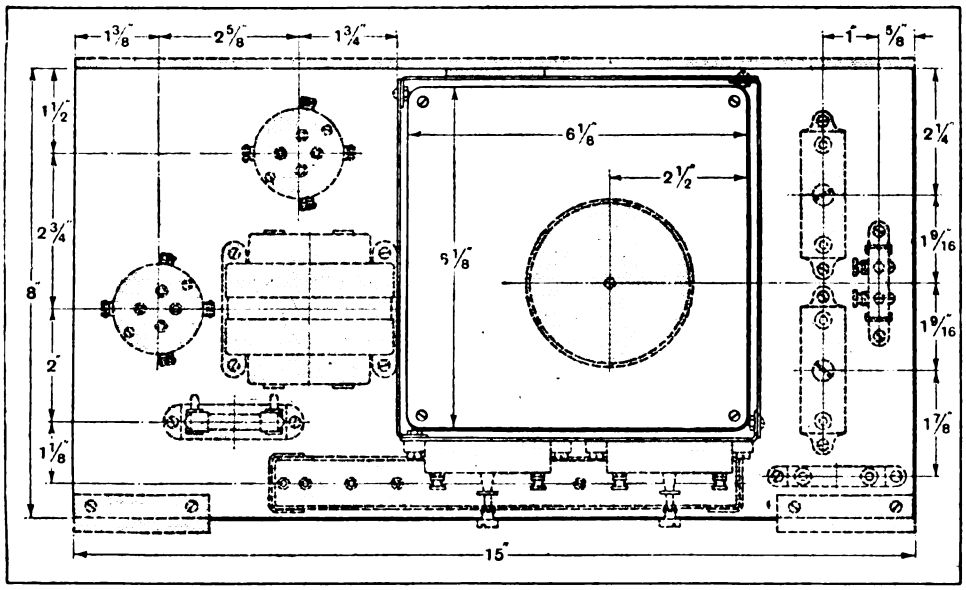

Fig. 4.—Layout of components on the baseboard. Note distance piece between screening box and panel.

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LIST OF PARTS.

1 Wood panel, 3-ply, 15×7in.
1 Wood baseboard, 5-ply, 15×8in.
1 Screening box, aluminium, 6½×6½×6in. high.
1 Inductance coil former, 3½×3in. dia. (Pirtoid).
1 L.F. transformer (Ferranti, A.F.5).
2 Valve holders (Burton, Midget).
1 Switch, 3-pole change-over (Burton).
1 Reaction condenser, 0.0001 mfd. (Burton).
1 Variable resistance (Standard Clarostat).
1 Single coil-holder (Lotus).
1 Coil, No. 40, centre-tapped (Lewcos).
4 Semi-variable condensers, 0.001 max. (Formodensers, Type G).
1 Resistance, 100,000 ohms (Ediswan).
1 Holder for above (Bulgin).
1 Fixed condenser, 0.0002 mfd. (Trix).
2 Terminal mounts (Junit).
4 Terminals: "Aerial," "Earth," "L.S.+," "L.S.—" (Eelex).
1 Grid bias battery, 15 volts (Ripaults).
1 Pair bias battery clips (Bulgin).
5 Wander plugs (Clix).
2 Spade terminals (Clix).
Sistoflex, wire, screws, etc.

Approximate cost, £4 2s. 6d.

In the "List of Parts" included in the descriptions of THE WIRELESS WORLD receivers are detailed the components actually used by the designer and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed, and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

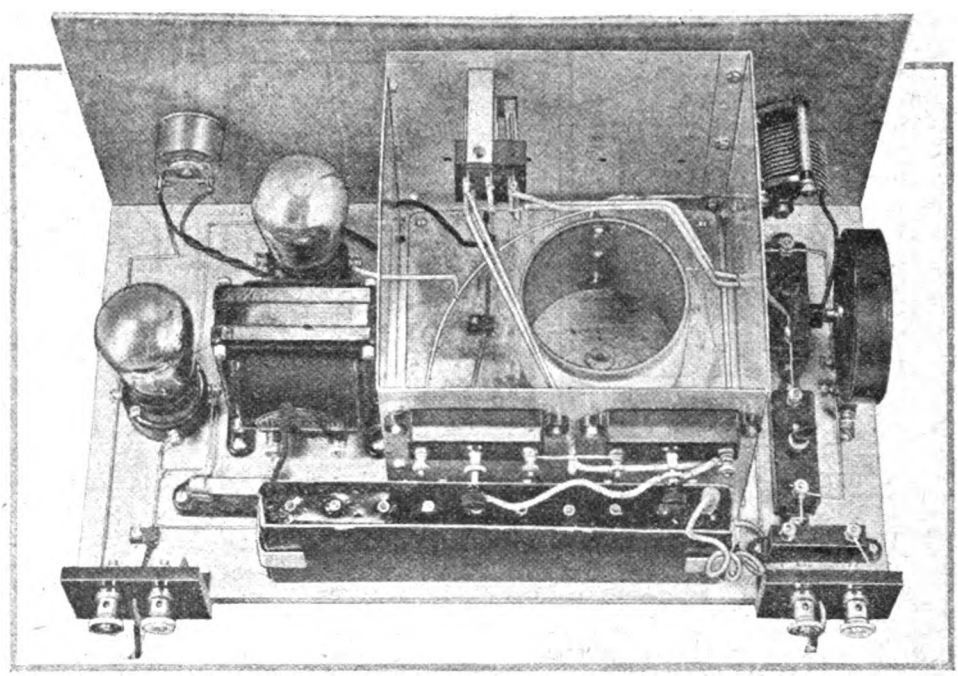
flexible leads for connection to L.T. and H.T. batteries are led out through holes provided in these blocks.

One can hardly go wrong in the wiring of a simple set of this type, particularly with the help of the diagram given in Fig. 5, but some attention should be paid to the connections between tuning condensers and switch, the leads being run parallel and close together in pairs, as clearly indicated both in the diagram and in the illustration on this page. This is to minimise stray inductive coupling due to the fact that the aerial circuit wiring at this point is of necessity passed into the secondary circuit screening compartment.

Apart from permissible modifications in design, a certain amount of latitude is allowable with regard to the choice of components. Semi-variable tuning condensers operate best towards the minimum end of their capacity range, as in this position a given rotation of the control knob brings about a much smaller capacity change than at the other end of the scale. To cover the wavelengths of the alternative London stations, Formodensers rated at 0.0002-0.001 mfd. (but actually with a slightly lower minimum) are accordingly used. Obvious adjustments as to values can be made when dealing with other wavelengths.

A transformer used for linking an anode-bend detector to a succeeding L.F. valve should be of first-class design, and must have a high primary inductance, which implies a low step-up ratio. Unless a high-grade transformer is used, it does not pay to employ this circuit arrangement. The detector valve itself should be one of the types specially designed for this particular function, and should have a rated impedance not appreciably greater than 10,000 ohms—preferably less. Marconi or Osram "D.E.L.," or Mullard "D" types are suitable. There is no need to discuss the output valve, of which the choice will, as usual, depend on current supply facilities and requirements as to volume.

While dealing with the question of volume it should be made quite clear that a simple set of this type can produce a really large output, always provided that sufficient energy is picked up by the aerial; and it must be remembered that extraordinarily high signal voltages are developed at a few miles' distance from the present high-power stations. A recent article[1] showed that an arrangement similar to that under discussion, with a P.M.6D. valve with 150 volts H.T. and 10½



Plan view. The separate pairs of tuning condensers are wired with parallel side-by-side conductors. Holes with an ample clearance are drilled to pass wires through the screening box.

[1] "The Valve as an Anode Bend Detector," *The Wireless World*, March 27th, 1929.

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Twin-station Two.—

volts bias, fed with maximum possible signal voltage consistent with avoidance of grid current, will provide a peak output of 110 volts (total swing), implying a bias of 55 volts for the L.F. valve. This is, of course, a much greater output than is ordinarily required, but it should be made quite clear that it is only attainable at a very short distance from the transmitting station.

With regard to the question of H.T. voltage, it is hardly fair to expect good results with a pressure of less than 100 volts; normally 120 volts may be regarded as a minimum. This may be increased to 150 volts with the usual gain, but if the supply is considerably greater than this it is as well to provide a separate connection for feeding the output valve. The receiver is not prone to troubles brought about by interaction, and consequently it may be fed from a simple—even a crude—eliminator.

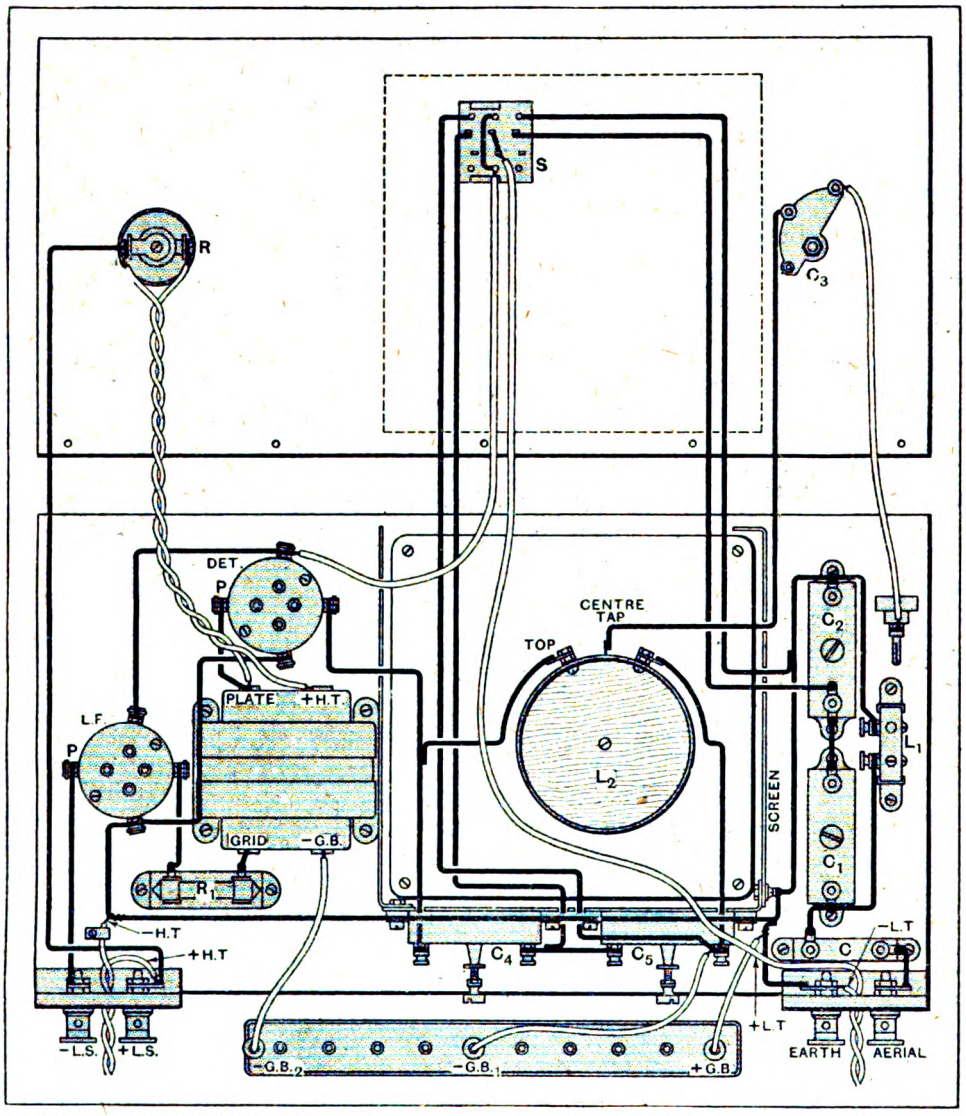

Fig. 5.—Practical wiring plan. Rigid conductors are used except where clearly shown to the contrary.

As a good deal of attention has lately been devoted to the question of operating two-circuit tuners, it is quite unnecessary to give lengthy instructions, but it should be emphasised that efforts should first be concentrated on the longer of the two wavelengths to be received, tuning with the condensers C_1 and C_4, while C_2 and C_5 are "shorted" by means of the switch. When making the short-wave adjustment with switch open and condensers in series, it will be found that the tuning of condensers C_2 and C_5 is now apparently "broad"; this is because their effective capacity range is reduced. This represents one of the advantages of the series method of connection when compression-type tuning condensers are used. The stations should first be tuned in with a very weak coupling (i.e., with a low-capacity setting of the condenser C_3), afterwards increasing strength if necessary by tightening coupling to the optimum value.

Except at very short ranges volume control will normally be effected by operation of the variable resistance R. With exceptionally large aerial inputs, distortion may be evident, even though this resistance may be set to such a low value that L.F. valve overloading is obviously impossible. These symptoms will indicate that the detector itself is overloaded, and the remedy is to reduce H.F. input to it by weakening coupling, afterwards bringing up intensity to the required level by rotation of the knob controlling R.

In situations where greater sensitivity than that afforded by the set described is necessary a stage of H.F. amplification may be added, with its tuned coupling controlled in the manner discussed. Generally speaking, it will be possible to omit the separately-tuned aerial circuit. Where a grid detector with reaction, followed by L.F. amplification, is preferred to an "H.F." set, the Hartley circuit, or one of its variants, is to be recommended, as it lends itself readily to easy wave-change switching with separate coils and condensers for each wavelength.

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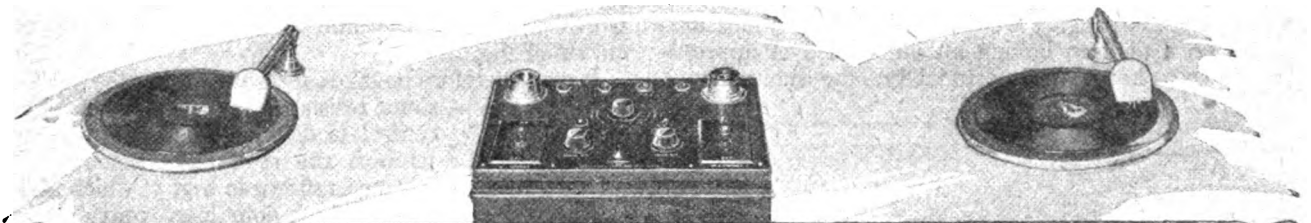

PICK-UP VOLUME CONTROL

Potentiometer and Variable Shunt Resistance Methods Compared.

By F. L. DEVEREUX, B.Sc.

THE voltage output from an electromagnetic pick-up is frequently in excess of the maximum input for which the associated amplifier has been designed. Further, the general level of output from records of different types varies between wide limits. A continuously variable volume control is, therefore, an essential component of any electrical gramophone equipment.

The simplest and most generally favoured method is to connect some form of variable resistance across the pick-up terminals in order that the voltage may be reduced to the required level before it reaches the grid circuit of the first amplifying valve. Properly applied, this method is quite sound, but there are one or two serious pitfalls to be avoided.

Matched Impedance.

Strictly speaking, an electromagnetic device such as a pick-up should be designed to work into an impedance of known value, e.g., the primary winding of an input transformer. When this is done, the correct procedure is to apply the volume control by means of what is known to telephone engineers as a "T" network. The opportunities of applying this method are, however, few, since the majority of commercial pick-ups are designed—or rather intended—to be connected direct to

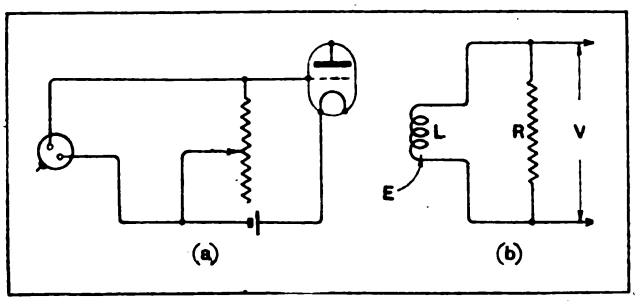

Fig. 1.—(a) Variable shunt resistance volume control producing high-note loss and (b) equivalent circuit.

the grid circuit of the first amplifier valve, i.e., to work into an infinite resistance or open circuit. In these circumstances the connection of a resistance across the pick-up terminals may result in serious high-note loss as the following examples show.

Let us suppose that a variable resistance R is shunted across the pick-up terminals as in Fig. 1 (*a*). For simplicity we will assume that the impedance of the pick-up windings is mainly inductive, in which case the equivalent electrical circuit will be as shown in Fig. 1 (*b*). The inductance L and resistance R will form a series circuit, and the alternating E.M.F. (E)

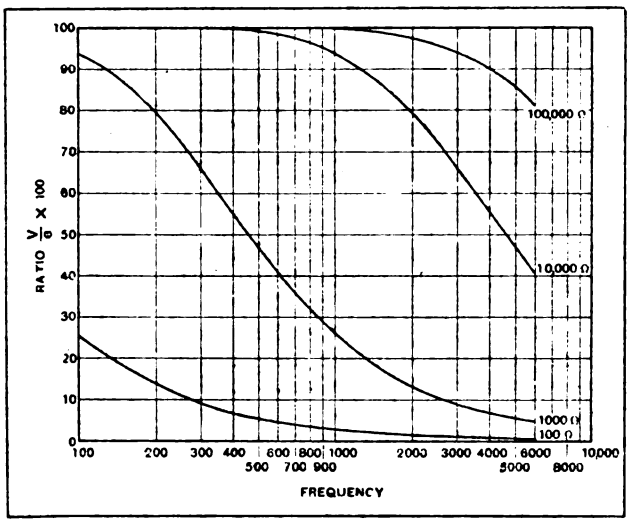

Fig. 2.—Calculated curves showing high frequency cut-off for various values of R in Fig. 1. It is assumed that the pick-up impedance is purely inductive and an inductance of 0.6 henry has been taken as a basis for calculation.

generated by the movement of the armature may be represented as being injected into the inductance L. The voltage drop V across R will be the voltage output to the first valve of the amplifier. For distortionless reproduction the relationship between V and E should remain constant for all frequencies. Unfortunately, the higher the frequency the higher becomes the impedance of L, until at very high frequencies R may represent only a small fraction of the total impedance of the circuit. Consequently, V at high frequencies is only a small fraction of the total E.M.F. (E) in the circuit.

The curves in Fig. 2 show that, as might be expected, the high-frequency loss is greater the lower the shunt resistance. For simplicity the D.C. resistance of the winding has been neglected; its effect will be considered later.

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Pick-up Volume Control.—

The curves of Fig. 3 are the result of actual measurements on a pick-up having an inductance of approximately 0.6 henry. Unfortunately, the mountainous

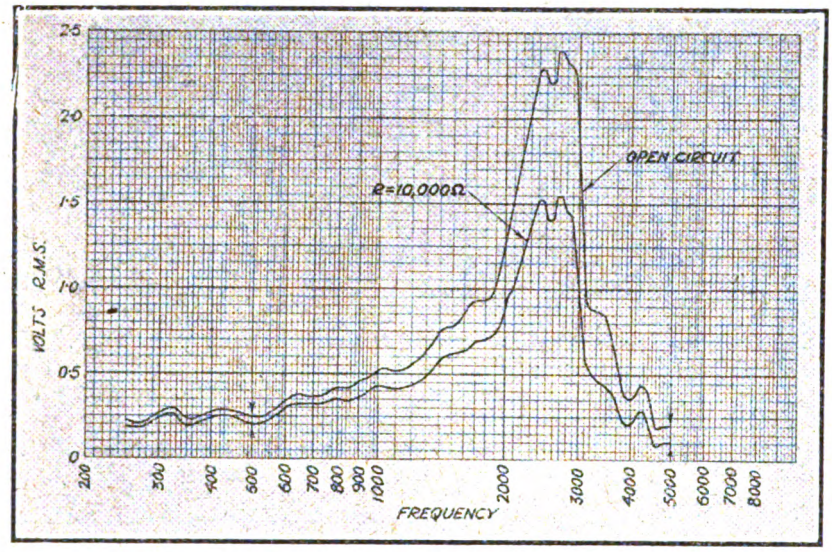

Fig. 3.—Characteristics of experimental pick-up with 10,000-ohm shunt and on open circuit. Comparison of the curves at 500 and 5,000 cycles where the output level is of the same order shows that the shunt resistance produces a greater reduction of output at the higher frequency.

nature of the curve somewhat obscures the progressive high-note loss. By comparing the difference in the height of the two curves at 500 cycles with that of 5,000 cycles, where the general level is approximately the same, it will be seen that whereas the 10,000-ohm shunt produces a reduction of only 20 per cent. at 500 cycles, the loss at 5,000 cycles is at least 50 per cent. Incidentally, these curves show that the resonance in the pick-up is mechanical, not electrical; otherwise the shunt resistance would have the effect of flattening the resonance peak.

The *percentage* difference in voltage output between the two curves, irrespective of variations in amplitude, is shown in Fig. 4. Comparing this with the 10,000-ohm curve in Fig. 2, it will be seen that they are in agreement at 5,000 cycles where the inductive impedance is high compared with the resistance. The practical curve, however, fails to reach the 100 per cent. line. This is accounted for by the resistance of the pick-up windings which was not taken into account in calculating the curves of Fig. 2.

It may therefore be taken for granted that the variable shunt resistance as a method of volume control is definitely bad. This leaves us with the alternative potentiometer scheme as shown in Fig. 5, which gives, without high-note loss, provided the total resistance of the potentiometer is sufficiently high, a range of volume from zero to maximum. Investigation of a number of representative commercial pick-ups indicates 0.25 megohm (250,000 ohms) as a good average value. In general the total resistance across the terminals should not be less than 100,000 ohms, but in the unlikely event of a pick-up being found with an excessive high-frequency output a lower value might be usefully employed to correct matters.

In conclusion, a word about the correct method of connecting a potentiometer. Many components of this type

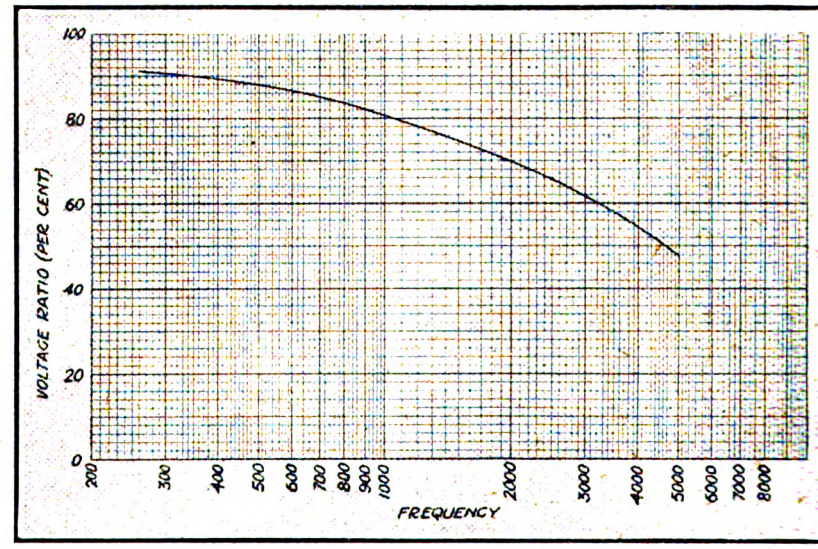

Fig. 4.—Curve derived from Fig. 3 showing percentage reduction of output with frequency due to 10,000-ohm shunt.

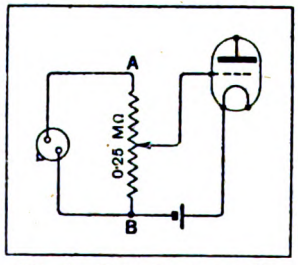

Fig. 5.—Potentiometer volume control. The high-note loss is negligible provided the total resistance of the potentiometer exceeds 100,000 ohms.

have a logarithmic distribution of resistance. In other words, the resistance change for a given angular movement of the contact arm is greater at one end of the scale than at the other. The reason for this is that the acoustic output from the loud speaker is proportional to the square of the input voltage from the pick-up. If the potentiometer resistance is divided logarithmically the sound output is evenly distributed over the range of movement of the contact arm. It is essential, however, to connect the ends of the resistance the right way round, otherwise the range of control will be crowded to one end of the scale. The low-resistance end should be connected at A in Fig. 5, and the high-resistance end at B.

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CURRENT TOPICS.

Events of the Week in Brief Review.

THE COMPLIMENTS OF THE SEASON.

To all readers of *The Wireless World* from the Arctic to the Antarctic we extend our best wishes for a Merry Christmas and a Happy New Year.

oooo

CHRISTMAS GREETINGS BY WIRELESS.

Special facilities for sending Christmas messages to ships at sea are announced by the Postmaster-General. From Rugby Radio greetings can be addressed to "ships on all seas" at 1s. 6d. a word. Ships up to five days from any British port can be reached *via* British and Irish land stations at 11d. a word.

oooo

BROADCAST "STUDIO" ON POLISH TRAIN.

The first of the wireless-equipped trains on the Warsaw-Cracow line is now ready, writes a correspondent. Each seat is fitted with a receiving point fed from a central receiver in a special "studio" which includes a microphone for announcements and a gramophone amplifier. Passengers pay a small fee for the hire of headphones, which are disinfected after use.

oooo

FRENCH BROADCASTING "WAR": ANOTHER STAGE.

The "Broadcast Defence Committee" is the name of an organisation formed in Paris by the minority party who are in favour of complete State control of broadcasting, writes our Paris correspondent. It is unlikely that the Committee will exert much influence on the progress of the broadcasting Bill, but as this intricate piece of legislation can hardly take practical shape before the autumn of 1930, the minority still hope that its terms can be modified. The Bill aims at creating a semi-State monopoly on the lines of the B.B.C.

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FRANCE WINS "SUPERHET" CLAIM.

M. Lucien Levy, the French wireless worker, has received official advice from the American Patent Office admitting his claim as the inventor of the superheterodyne. The claim was also recognised recently by the German Patent Office.

oooo

WHAT IS YOUR WAVELENGTH?

"Every man has his own wavelength," declares Dr. Moineau, a French scientist, who claims to have invented an animal wavemeter. He states that human beings radiate waves of between 22 and 45 millimetres. The new police radio organisation in France should make a note of this.

oooo

5SW RELAYED IN AMERICA.

5SW, the short-wave broadcast station at Chelmsford, and the Post Office telephony station at Rugby, both transmitted Marchese Marconi's speech from a B.B.C. studio on December 12th when the inventor described his first experiments in Transatlantic wireless telegraphy twenty-eight years ago. The 5SW transmission was selected by the Radio Corporation of America for relaying to listeners in the United States. Many enthusiastic reports have been received.

oooo

HIDDEN ADVERTISEMENTS COMPETITION.

A large number of readers entered for the Hidden Advertisements Competition in our issue of December 11th, and the following are the prize-winners:—

1st Prize (value £7 10s.): Herr Robert Käubler, Jordanstr 31, Dusseldorf, Germany.

2nd Prize (value £5): Mr. Alfred Jackson, 48, Fenwick Road, Peckham, S.E.15.

3rd Prize (value £2 10s.): Mr. Maurice R. Guy, 70, Cambridge Road, New Malden, Surrey.

Consolation prizes (each to the value of £1) are awarded to the following: Mr. S. H. Lewis (Guildford), Mr. R. de S. Stawell (Falmouth), Mr. R. Harrison (London, S.E.3), Mr. J. Lovell (Brigg, Lincs), and Mrs. M. Martin (Edinburgh).

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WORLD BROADCASTING ON FIFTEEN WAVELENGTHS.

Long-distance listeners who are seeking fresh worlds to conquer can begin with the New World by picking up the G.E.C. transmissions from Schenectady (New York). Some fifteen channels are now in use, ranging from 790 kilocycles (380 metres) to 23,080 kilocycles (13 metres), the last-named being that of W 2XAW.

For broadcast to foreign countries considerable use is made of W 2XAF, 31.4 metres (9,530 kC.), and W 2XAD on 19.6 metres (15,340 kC.), but experimental transmissions are also carried out on 187.4 metres (1,604 kC.), 125 metres (2,398 kC.), 100 metres (3,256 kC.), 62.6 metres (4,795 kC.), 46.7 metres (6,425 kC.), 34.7 metres (8,650 kC.), 23.4 metres (12,850 kC.), and 17.3 metres (17,300 kC.).

The following call-signs are used indiscriminately, viz., W 2XAZ, W 2XAH, W 2XK, W 2XAC, W 2XO, W 2XAH, and W 2XAK, in addition to W 2XAW already mentioned.

Television tests are conducted on about 139.5 metres with the call-letters W 2XCW. All telephony tests with aircraft are carried out on 130.4 metres (230.2 kC.) and 97.3 metres (3,076 kC.) with the call-sign W 2XCH.

oooo

RADIO MANUFACTURERS' ASSOCIATION.

Captain J. W. Barber, of the Brownie Wireless Co. of Great Britain, has been elected chairman of the Radio Manufacturers' Association in succession to Mr. John T. Mould. The new vice-chairman is Mr. R. M. Ellis, of Climax Radio Electric.

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THE PARALLEL-FED L.F. AMPLIFIER.

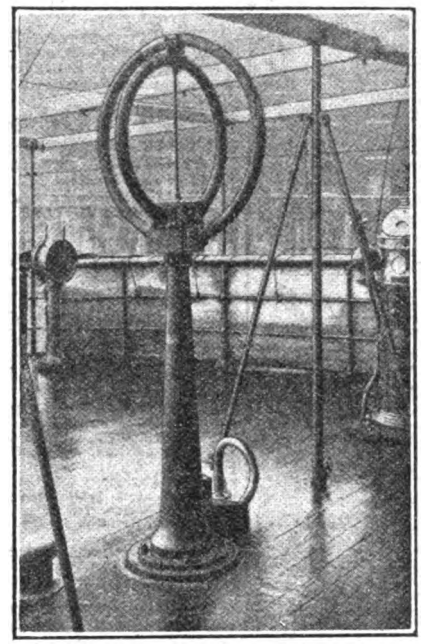
It is regretted that an error occurred in the appendix to the article "The Parallel-fed L.F. Amplifier" on p. 647 of our issue of December 11th. The design formula should read thus:—

$$C = 2L\left(\frac{B}{A}\right)^2 \quad \text{Where } A = R_a + r + \frac{R_a}{R}r = R_a + Br$$

$$B = 1 + \frac{R_a}{R}$$

Lines 31, 32, 33, second column, p. 644, should therefore be read: ". . . the resistance r representing the transformer primary resistance."

SOUTHWARD HO! Operating the Marconi direction finder in the chart room of "Discovery II," the Royal research ship which left London on December 14th for a three years' scientific research voyage in the Antarctic.



DIRECTION FINDING IN THE ANTARCTIC. The Marconi direction-finder aerial on the bridge of "Discovery II."

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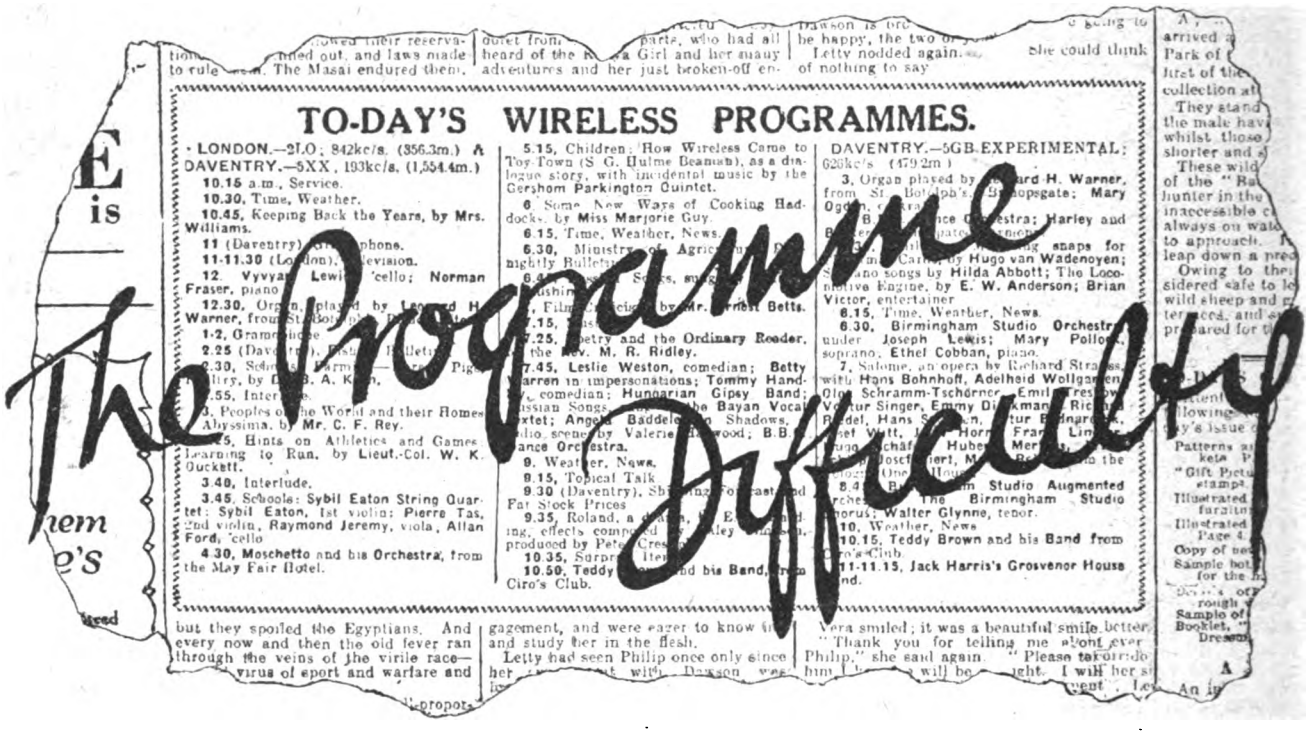

A Low-power Synchronised Transmission Scheme.

By HUMPHRY MacCALLUM, B.Sc.

ONE of the advantages of the gramophone, as compared with radio, is that, within the limits of your means or your foresight or your borrowing capacity, you can listen when you like to what you like; one of the limitations of radio is that you cannot do so. If you have a gramophone and access to records of all sorts you can make your own programmes and you can make them just when you want them. But with radio you have a limited choice, since you can listen only to what is in the programmes of those stations that are broadcasting at the moment and happen to be within range.

Radio can give quality reception which is beyond serious criticism, quality which can be relied upon to please the discriminating ear of the music critic, and indeed of the musician himself—provided he is satisfied to forgo long-distance reception and to rely almost entirely upon the fare offered by the B.B.C. But at present this is not an altogether attractive prospect. The most enthusiastic supporter of the B.B.C. is forced to recognise that there are periods during which individuals or groups, if not whole classes, of listeners are thoroughly bored. On some occasions, indeed, listeners are transported beyond the boundaries of boredom to the regions of exasperation.

One cannot blame the B.B.C. programme department for this. They have done more than well with the limited facilities at their disposal, for they have at least succeeded in providing programmes which, on the whole, have been sufficiently attractive to make broadcasting a feature in the lives of the people.

It is quite definitely impossible to please everyone with one programme, or even with two programmes, though the availability of an extra programme is an immense step in the right direction. If you remove the church service to please the radio dealer, who does not want to talk shop to an accompaniment of the Psalms, you will most certainly upset a large body of serious-minded listeners, and if, in response to the clamour of the afternoon dance enthusiast, you discontinue the fading out of so-and-so's orchestra which prefaces the friendly "Good afternoon, scholars," you will upset another, perhaps larger, body of serious-minded listeners. Clearly you can't do much with one programme. In present circumstances the alternative programme is, as a rule, either inaccessible to the listener or is received at diminished volume, and in any case it is rarely a true alternative, which, of course, detracts immensely from its value.

The scheme of broadcasting suggested in this article is designed to ensure that the listener will receive a true alternative which is, to an extent, of his own selection, and that he will not find himself asked to listen to some-

THE writer, who was intimately associated with British broadcasting in its earliest days, suggested the sites for the original chain of 1½ kw. stations which has held sway, with modifications, for the last seven years. While "The Wireless World" disclaims responsibility for the views expressed in this article, it is felt that they are worthy of more than passing attention.

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The Programme Difficulty.—

thing he does not want to hear. If it is adopted, our dance enthusiast will not have his dance music faded out to give place to the unexpected and unwanted voice of the scholar's mentor. The susceptibility of the religiously inclined will not be shocked by the change from a religious address to a secular concert. The earnest scholar will have facilities for gleaning the knowledge he so assiduously seeks. The highbrow will have his heights and the lowbrow his depths. Mayfair and Kensington, Peckham and Tooting, Mile End Road and Dockland, will have programmes to their liking, and all these not at arbitrary times fixed by the B.B.C. but, as far as possible, continuously available at the will of the listener.

The Listener to Choose His Fare.

The means by which these alternatives can be provided appear to be quite practicable, and it is somewhat remarkable that they have not previously been suggested. They will be dealt with shortly. In the meantime it will no doubt be universally agreed that the provision of alternatives in the manner indicated is eminently desirable. It would even seem that the introduction of a scheme providing such facilities would result in radio receiving an impulse of the most powerful kind and that, because of the new possibilities, its future prospects as a means of entertainment and education, as well as an industry, would be considerably greater than has hitherto been considered to be the case.

The essential point in the suggested scheme is that the listener shall himself be able to select what class of entertainment he is to listen to, and to change at will to a true alternative programme. An individual listener does not always want to listen to the same type of entertainment. While detesting talks, Brown, who is an enthusiastic motorist, may be anxious to hear an address by Sir Henry Segrave. Jones, who, as a rule, considers the News a waste of time, may tune in to see whether Compston has beaten Hagen at golf, though normally he would wish to listen to dance music at that time of the evening. Robinson is a bee expert and of musical taste as well. He usually listens to symphony concerts and the like, but a talk on bees will lure him away from his normal vogue. And so on and so forth.

Now if Brown and Jones and Robinson have the choice of, let us say, four programmes which we may call A, B, C, and D respectively, and if—and this is the essence of the proposition—they all know that talks on bees can only be heard from station D, and that symphony music can only be heard from station B, that golf reports emanate from station C, from whence also comes Sir Henry Segrave's address, and so on, then every listener by tuning in to one or other of the four alternatives, will make sure of hearing at any rate the *class* of broadcast he wishes to hear at that particular time.

FIRST STEPS IN BROADCASTING. A photograph taken in the tiny studio at Marconi House in 1922. In the early days the technical novelty of broadcasting overshadowed programme considerations.

Common Wavelengths Synchronised.

To make this perfectly clear we can assume a hypothetical table of programme classification as follows:—

Station A.—Broadcasts only "popular" entertainment.

Station B.—Broadcasts only "highbrow" entertainment.

Station C.—Broadcasts Time, News, Weather, Politics, Talks (other than educational), etc.

Station D.—All Educational and Religious broadcasts from this station.

This classification is merely by way of suggestion in order to fix ideas. That eventually adopted would, no doubt, be the result of a somewhat interesting research carried out by the programme department of the B.B.C. on the lines indicated.

The four-programme scheme might have been introduced in 1922, when what became the B.B.C. chain of stations was under consideration. Four high-power stations grouped together at, say, Daventry, would have filled the bill. But in those days the authorities were hard-hearted on the subject of power, which was limited to 1½ kW. There are obvious drawbacks to this method, however, and in any case the time for its adoption is past, if only because there now exists a large body of listeners who regard themselves as having a vested interest in their own particular local station. Any scheme which does not meet this difficulty cannot be considered seriously.

An alternative four-programme scheme with fewer drawbacks, and one which appears to have the merit of novelty, is based upon the use of one wavelength for a number of stations sending out simultaneously the same programme.

Recent research has disclosed the fact that although the common use of one wavelength by stations sending out different programmes is unsatisfactory, if not unworkable, excellent reception over a limited area surrounding each station can be assured when two or more perfectly synchronised stations are sending out the same programme. The attempt at sharing common wavelengths with Continental stations was doomed to failure because the programmes differed and because synchronisation was imperfect. Where all the stations taking part

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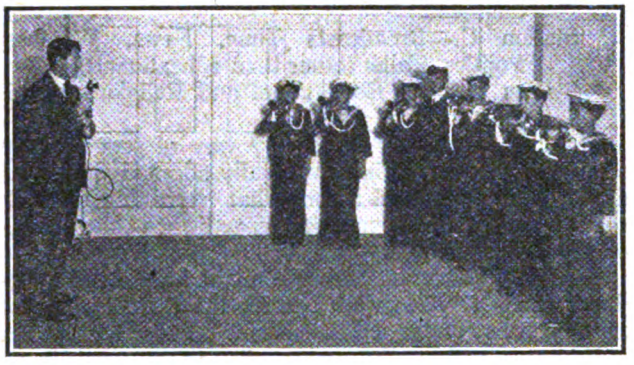
in the scheme are under one control, as in the case of the B.B.C. stations, conditions are favourable for best results in regard to synchronisation, and the B.B.C. engineers have shown that it is possible to maintain stations permanently synchronised under practical conditions. The provision of identical programmes is mainly a matter of land-line facilities, though in certain cases a radio link becomes possible without increasing the number of wavelengths in use.

The scheme now put forward is based upon the use of low-power stations using four wavelengths but, to



AN EARLY "SURPRISE ITEM." Boys of the training ship "Exmouth" broadcasting a bugle call from Marconi House.

meet certain limitations, two additional stations of high power, operating on two extra wavelengths are suggested. The total number of wavelengths required for the whole country would, therefore, be six, one of which might be the existing 5GB wave, and another the 5XX wave.

One Station, Four Wavelengths.

At present we are using ten wavelengths; there is therefore a saving in this derection which would allow for extra wavelengths for television or other services, or alternatively, would allow for wider spacing between the used wavelengths and therefore less liability of interference.

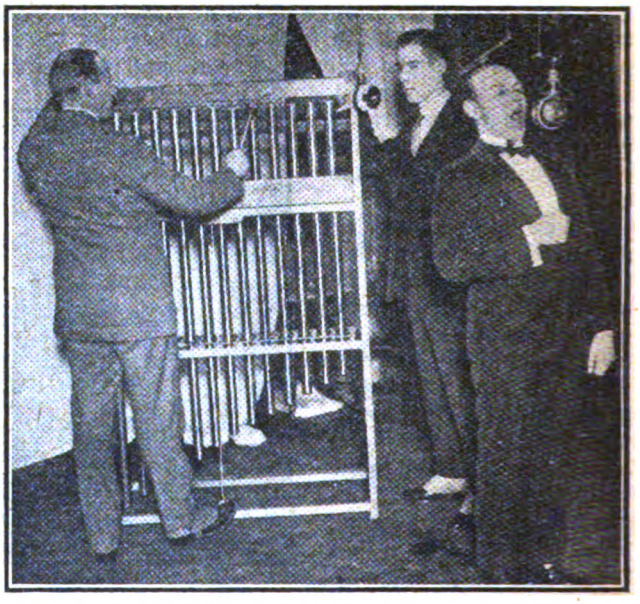
The main scheme provides only for densely populated districts. The two extra stations are intended to provide for the sparsely populated areas, the inhabitants of which, under the new scheme, would have the choice of two British programmes only and, of course, such Continental programmes as their apparatus enabled them to pick up. The sparsely populated districts will suffer by comparison with the centres of population, but this is only relative, and owing to considerably improved programmes and less interference the listeners in these districts will really be better off than at present.

Listeners at centres of population will have a full choice of four alternative programmes classified in the manner suggested, and available at good strengths and of ideal quality. For them at any rate, i.e., for the vast majority of the population, the scheme would appear to provide a complete solution to existing programme difficulties.

What can we find against this ambitious scheme? The technical difficulties do not appear to be insurmountable. We know it is possible to send out four programmes on four different wavelengths from one broadcasting centre, and Captain Eckersley has published results from which we are entitled to deduce that such centres can be duplicated or multiplied within reason as required without increasing the number of wavelengths in use.

The Financial Aspect.

Is the scheme financially unsound to a degree that would put it out of court? Will it cost too much to broadcast four waves from each important centre of population? Will it cost too much to provide four classes of programme continuously? Figures are not available, but it would seem reasonable to suppose that a very greatly increased revenue from licences would result from the introduction of the scheme, and that this would more than provide for any increased expenditure. Each centre of population would, in a sense, become self-supporting. The larger centres, like London, Manchester, etc., might be expected to contribute, through the medium of licences, sufficient funds to cover the provision of the four simultaneous broad-



SATISFYING THE PIONEER LISTENER. In 1922 the only instrument which was faithfully reproduced throughout its range of frequencies was the set of tubular bells seen in the picture. Listeners were delighted!

casts at appropriate power, whereas smaller centres, though less important financially, might be expected to contribute funds sufficient to provide for the needs of the districts which would be met by a simultaneous broadcast on reduced power.

It is possible that the scheme might be developed along these lines to an extent which would enable quite small centres of population to come in economically, and by a low-power local broadcast add one or more programmes to those already received from the high-power stations, without increasing the number of wavelengths in use. A series of such stations held at the disposal of the Educational Authorities, and paid for

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The Programme Difficulty.—

by Government grant would give free scope for educational activities and avoid the necessity for interfering with the two high-power programmes.

It will be realised that the cost of producing programmes is not likely to increase abnormally, since four only are required for the whole country. Each may be the very best of its class, and fees will be correspondingly heavy, but a counterbalancing economy results from the fact that there is no duplication as at present with the large number of stations in existence.

The scheme suffers from the drawback that it fails to provide for the programme of purely local origin. The best of the "local" items will find their outlet, however, in the appropriate national programmes.

A further, though not very serious, disadvantage of the suggested scheme lies in the possibility of items of equal attraction to the individual listener running concurrently in different programmes. Robinson's "talk on bees" might conceivably coincide with his favourite symphony, and he would perhaps be annoyed at not being able to hear both. But this class of fault is surely outweighed by the many good points of the scheme, which may be summarised as follows:—

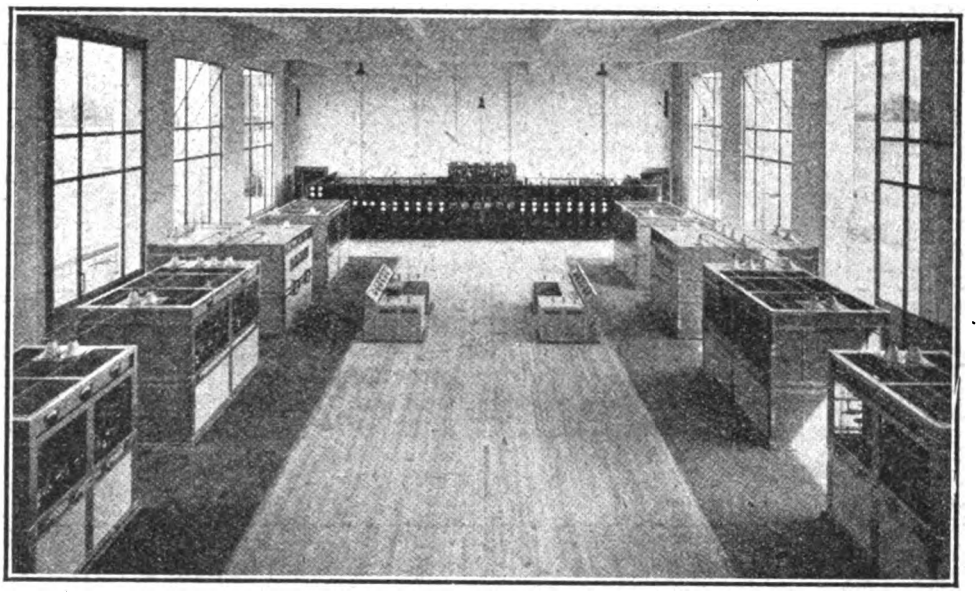
(1) A greater choice of programmes than has hitherto been possible is provided at good strength at all important centres of population. Every listener at these centres has available, at equal strength, and all the time during broadcasting hours, four different classes of programme.

(2) Considerable economy in wavelength is obtained, the whole country using six waves only for home broadcasting purposes.

(3) The cost of programmes is reduced and/or their quality improved, since only one first-rate programme of each class is required instead of some half dozen second-rate programmes, as at present.

(4) Long-distance listening, with its unavoidable unreliability, is discouraged by the provision of reliable near-by transmissions of the very best quality, offering a choice of programme unobtainable elsewhere. As a result of this, radio is likely to assume a popularity far in excess of that held by it at present, and, indeed, in excess of the wildest dreams of its most ardent supporters.

(5) Although the scheme provides continuous and unlimited entertainment of a type suited to every class of listener, it also provides uninterrupted scope for programmes of an instructional, educational, political, and religious type. The conflict of interest between the various sections of thought regarding the provision of programmes automatically comes to an end since each section has a free choice of sufficient alternative programmes at adequate strength.



IS THIS TYPE OF TRANSMITTER NECESSARY? The twin transmitters at Brookmans Park, which, if our contributor's scheme were to materialise, would be the biggest white elephants in the zoology of the ether.

It would seem that the scheme carries with it so many important advantages that it is at least worthy of serious consideration, and, should it prove to be practicable, its introduction by the B.B.C. will exterminate for ever the persistently recurring slander anent the intention of that body to provide what it considers to be good for the people rather than what the people consider to be good for themselves.

CATALOGUES RECEIVED.

The Marconiphone Co., Ltd., 210-212, Tottenham Court Road, London, W.1.—Publication No. 585a, revised edition of new catalogue containing full description of the Marconiphone range of receiving sets, loud speakers and gramophone pick-up.

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The Halcyon Wireless Co., Ltd., 313-319, Regent Street, London, W.1.—Illustrated folder dealing with two new 4-valve transportable receivers recently introduced.

Cambridge Instrument Co., Ltd., 45, Grosvenor Place, London, S.W.1.—Illustrated leaflet of the Cambridge Surface Pyrometers, an instrument to provide accurate and convenient means of determining the inside temperature of bakelite and other moulding material during the process of manufacture.

Tungstone Accumulator Co., Ltd., 3, St. Bride's House, Salisbury Square, London, E.C.4.—24-page book describing and illustrating the construction of the paste-filled lead-grids used in Tungstone batteries. Also illustrated folders of H.T. and L.T. batteries for wireless use.

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The Mainten Manufacturing Co., Ltd., Portland Road, Hove, Sussex.—Descriptive folders dealing with the range of battery eliminators, all-mains receivers, and metal cabinets manufactured by this firm.

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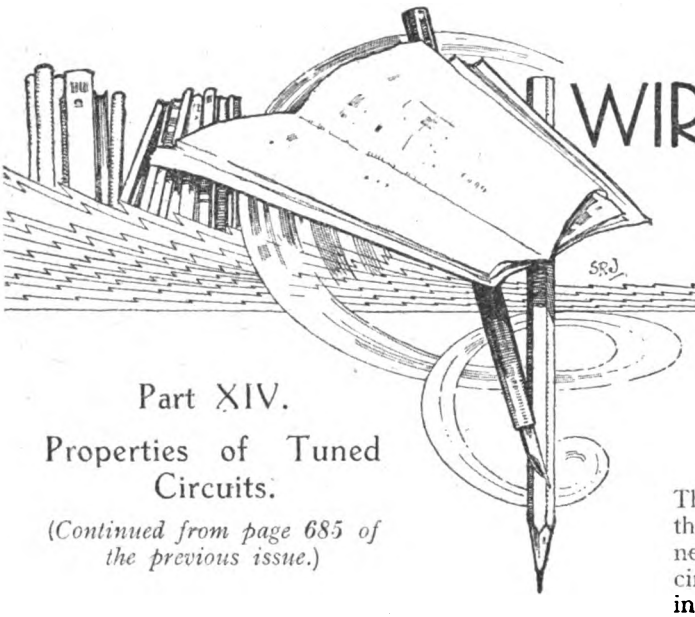

WIRELESS THEORY SIMPLIFIED

Part XIV.

Properties of Tuned Circuits.

(*Continued from page 685 of the previous issue.*)

By S. O. PEARSON, B.Sc., A.M.I.E.E.

IT was shown last week how a series of circuit possessing inductance and capacity was capable of selecting currents whose frequencies were near the resonant frequency of the circuit whilst choking back currents with frequencies outside this band. Since the circuit allows maximum current to flow at the resonant frequency it is sometimes called an "acceptor circuit." It will be seen later that the parallel circuit has the reverse effect, and it is referred to as a "rejector circuit."

The resonant frequency of a series circuit is quite independent of the resistance, being determined by the product of inductance and capacity only, its value being $f = \frac{1}{2\pi\sqrt{LC}}$ cycles per second, but the amount of current passed at this frequency is determined by the resistance alone for a given applied voltage, because the respective reactances due to the inductance and capacity neutralise each other's effects completely at the resonant frequency.

The Closed Circuit.

To study the properties of a tuned circuit profitably we must do so from a practical point of view; that is to say, we must know the conditions under which the circuit is going to be used in practice and then find out the conditions in the circuit which will make for the highest efficiency.

The commonest example of a series tuned circuit in a wireless receiver is the ordinary tuned grid circuit preceding the first valve, *where the aerial is inductively coupled to the tuning coil* as shown in Fig. 1 (*a*).

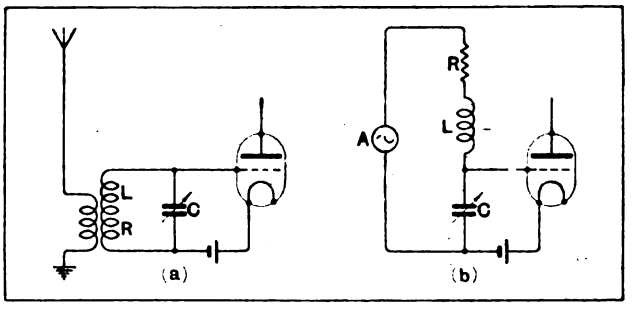

Fig. 1.—(a) Typical tuned grid circuit inductively coupled to the aerial. The tuned circuit is electrically equivalent to the series circuit shown at (b), where A is the source of alternating E.M.F. energising the circuit.

The alternating current in the aerial coil, produced by the signals being received, causes an alternating magnetic field to be linked with the coil L of the tuned circuit, and this in turn induces an alternating E.M.F. in the latter coil. Let the R.M.S. value of this voltage be E. This voltage will, of course, drive an alternating current round the closed circuit, R, L, C and the value of this current will be $I = \frac{E}{Z}$ amperes, where Z is the total impedance of the circuit.

Clearly we should get exactly the same effect if, instead of *inducing* the voltage E into the closed circuit by mutual induction, we were to connect a generator giving E volts at the same frequency anywhere in the circuit. This means that our closed circuit with applied E.M.F. induced in the coil is electrically equivalent to a series circuit with the voltage E applied to its ends as shown at (*b*) in Fig. 1. This is a point of fundamental importance; any closed circuit where the applied E.M.F. or energising E.M.F. is *induced* into it is equivalent to a series circuit; the current round the closed loop is simply given by $\frac{E}{Z}$, where Z is the impedance due to R, L and C in series.

Voltage on the Grip of the Valve.

The valve depends for its action on the application of an alternating *voltage* between the control grid and filament and does not consume any current other than the small fraction of a microamp required to charge and discharge the grid when the valve is working under proper conditions. So the valve has its grid and filament connected across the condenser (or across the coil) of the tuned circuit as shown in Fig. 1 (*a*).

Now the voltage across the condenser is $I \times \frac{1}{2\pi fC}$ volts, where I is the current in the closed circuit and

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Wireless Theory Simplified.—

$\frac{1}{2\pi fC}$ ohms is the reactance of the condenser. Thus the voltage applied to the valve is proportional to the current in the closed circuit and inversely proportional to the frequency. Obviously then the performance of this stage of the receiver will depend on the general characteristics of the resonance curve obtained by plotting the voltage across the condenser against the frequency rather than on the simple current resonance curve found previously. The required voltage resonance curve can be found very simply from the current curve merely by multiplying the current at a number of different frequencies by the condenser reactance at the respective frequencies.

The voltage resonance curve is necessarily not quite the same shape as the current curve, because in obtaining it we are multiplying the current values by a variable quantity—the frequency. In order to show the difference the values of voltage across the condenser have been worked out for the same circuit constants which were used before, namely, L=2532 microhenrys, C=0.00025 microfarads, and R=500 ohms. But this time the voltage applied to the circuit is taken as 0.1 volt instead of 10, that is to say, in the circuit of Fig. 1 (*a*), 0.1 volt is induced into the coil L, so that the current values shown in the last column of the table given in Part XIII are just a hundred times greater than in the present case.

The resonant frequency is 200 kilocycles per second and at this frequency the current in the closed circuit is a maximum, being $\frac{E}{R}=\frac{0.1}{500}$ ampere or 0.2 milliampere, and the reactance of the condenser is $X_c=3182$ ohms. Hence at the resonant frequency the voltage applied to the grid of the valve is $E_c=IX_c=0.0002\times 3182=0.636$ volt. Note that this is 6.36 times greater than the voltage induced into the circuit by the aerial current even though the tuned circuit has the abnormally high value of 500 ohms.

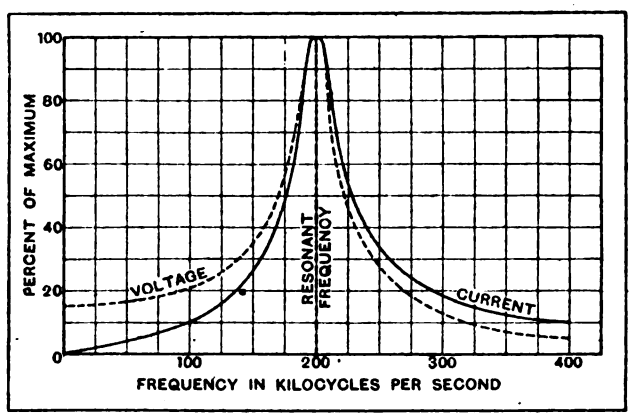

Fig. 2.—Current and voltage resonance curves for a series circuit. The values of each are plotted as a percentage of the maximum value to facilitate comparison. L = 2532 microhenrys. C = 0.00025 mfd. R = 500 ohms.

Frequency Kilocycles per sec.	Condenser Reactance.	Current Milliamp.	Voltage across Condenser.
20	31,820	0.00317	0.101
40	15,910	0.0065	0.103
80	7,955	0.0149	0.119
120	5,303	0.0292	0.155
160	3,978	0.0662	0.263
200	3,182	0.200	0.636
240	2,651	0.0789	0.209
300	2,121	0.0370	0.0785
350	1,818	0.0264	0.048
400	1,591	0.0208	0.033

At the moment we are concerned with the shape of the voltage resonance curve and will return to the voltage step-up effect later.

The table gives the values of current, the reactance of the condenser, and the voltage across it for various frequencies between 20 and 400 kilocycles per second, the other conditions being as given above.

In order to make it easy to compare the shape of the voltage curve with that of the current curve, instead of plotting the actual values of current and voltages against the frequency, each is plotted as a percentage of the maximum value to a common base line denoting frequency values in Fig. 2. For instance, at 160 kilocycles per second the current is 0.0662 milliampere or 33.1 per cent. of the maximum value of 0.2 milliampere. By adopting this expedient the peaks of the curves are made to coincide.

The current curve is shown as a full line and the voltage curve as a broken line.

Although it can be shown mathematically that the peaks of the two curves do not occur exactly at the same frequency they are so close together for all normal values of circuit resistance that we can assume that they coincide at the resonant frequency. But it is clear that for frequencies far removed from the resonant value the two curves are rather widely separated; but even so, they are very similar in shape.

Conditions for Maximum Signal Strength.

From the resonance curves of Fig. 2 we see quite definitely that the voltage applied between the grid and filament of the valve will be a maximum when the current in the closed circuit is greatest at the resonant frequency. As explained, this current is determined alone by the resistance of the circuit and so from the point of view of obtaining the greatest signal strength it is of prime importance to make the resistance of the tuned circuit a minimum. At high frequencies the resistance of the tuning coil depends not only on the size of wire with which it is wound, but on other factors to which a section will be devoted at a later date.

In the actual circuit we have been discussing a resistance of 500 ohms was chosen to simplify the calculations and to accentuate the effects of the resistance relatively to the other constants. Even with a resistance as high as 500 ohms, in a circuit where L=2532 microhenrys and C=0.00025 microfarads, the voltage built up across the circuit at the resonant frequency was seen to be 6.36 times greater than the E.M.F. induced into the circuit. If the resistance were reduced to 50 ohms, a more practical value, the current in the circuit would be increased tenfold at the resonant frequency and the voltage across the condenser would be 63.6 times greater than the incoming

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Wireless Theory Simplified.—

voltage. The importance of keeping the resistance down will thus be evident.

To show the important effect of resistance in this direction a number of current resonance curves are given in Fig. 3 for a circuit with the same inductance and capacity values as before but with different values of resistance as marked on the individual curves. It will be seen that the peaks of the curves have varying heights according to the resistance, but that they are all about the same width near the bottom. The values are worked for a voltage of 0.1 induced into the coil.

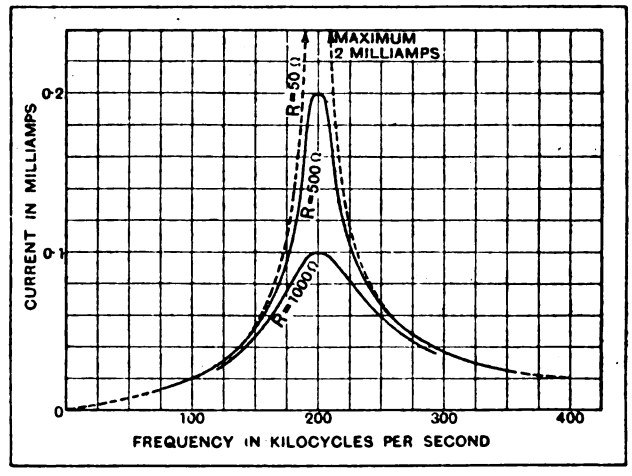

Fig. 3.—Current resonance curves for series circuit showing the effects of resistance. L = 2532 microhenrys. C = 0.00025 mfd.

How the Values of L and C Affect the Signal Strength.

It was shown that the voltage applied to the valve grid at the resonant frequency is not only proportional to the current in the circuit but also inversely proportional to the capacity of the tuning condenser. Now since the frequency to which the circuit is tuned is given by $\frac{1}{2\pi\sqrt{LC}}$ cycles per second it follows that the resonant frequency is determined by the *product* of inductance and capacity. Hence, if the inductance were doubled and the capacity halved the product would still be the same and the circuit would still be tuned to the same frequency. Furthermore if the resistance were not increased in the process the value of the current circulating round the circuit at the resonant frequency would be unchanged and so the voltage across the condenser would be doubled.

The inference is that for high voltage step-up in a tuned series circuit the ratio of inductance to capacity should be kept as high as possible. But of course a coil of higher inductance necessarily incurs an increase of resistance as more turns, usually of thinner wire, are required and so the gain in voltage is partly off-set by a reduction of the current. In practice we must strike a compromise which gives the optimum voltage step-up effect. The tuning condenser is usually a variable one, the inductance being fixed and in normal practice the value of inductance is so chosen that the maximum wavelength or minimum frequency to which the receiving set is required to tune calls for a variable condenser whose maximum value of capacity is of the order of 0.00025 to 0.0005 microfarad.

A tuned circuit where a variable condenser is employed gives the greatest voltage step-up effect at the higher end of the frequency scale or lower end of the wavelength band when the condenser is set to low values of capacity.

(To be continued.)

CLUB NEWS.

How Mains Sets Work.

The Philips 4-valve receiver was the subject of a lecture given by Mr. Cooper, of Philips Lamps, Ltd., on Friday, December 6th, before the Bristol and District Radio Society in their Club Room at Bristol University. By means of blackboard diagrams, the lecturer clearly explained how the A.C. mains were utilised for the working of wireless receivers.

The Annual Meeting of the Society will be held on January 24th, when it is hoped that all members will be present. Full details of the Society may be obtained from the Hon. Secretary, Mr. S. T. Jordan, 1, Myrtle Road, Cotham, Bristol.

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Valve Manufacture Described.

A lecture on valves given by Mr. W. L. Hartshorne, of Messrs. Cossor, Ltd., was the chief item of interest at a recent meeting of Slade Radio (Birmingham). Many important details of manufacture were explained, while samples of the various parts exhibited were submitted to a searching examination by a group of interested members.

Details of the Society's activities may be obtained from the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

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An Amplion Demonstration.

A large and enthusiastic gathering greeted Mr. P. K. Turner, of Graham Amplion, Ltd., for his lecture and demonstration of one of the Amplion A.C. mains receivers before the Muswell Hill and District Radio Society on December 11th. The necessary alternating current for the set was obtained from an A.C. generator running off the D.C. mains. Mr. Turner dealt with numerous points of design in the receiver and showed how good quality had been secured despite the use of reaction; though the judicious use of the latter, together with a screened grid valve, suited the set admirably for distant reception, as was proved in the subsequent demonstration, when numerous Continental stations were picked up at excellent strength with only an apology for an aerial.

Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road, London, N.10.

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Photo-electric Cells.

Photo-electric cells were described and demonstrated by Mr. Walker, of the General Electric Co., at the meeting of the Tottenham Wireless Society on December 3rd. With the aid of lantern slides the lecturer explained their theory and present-day use, concluding with a demonstration showing their capabilities in street lighting control.

Hon. Secretary, Mr. W. Bodemeaid, 10, Bruce Grove, Tottenham, N.17.

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Mains Set Operation.

The operation of radio receivers from the mains formed the subject of a constructive lecture given by Mr. Wyborn, of Messrs. Ekco, Ltd., at the last meeting of the Southend and District Radio Society. The lecturer started with the simplest form of high tension eliminator for direct current mains. He pointed out difficulties in operating sets arising from this elementary apparatus. From this he proceeded in stages to a final high efficiency type suitable for powerful and complicated receivers used on the roughest of mains.

Hon. Secretary, Mr. F. J. Waller, Lynthorpe Grange Gardens, Southend-on-Sea.

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H.F. Amplification: Old and New.

A practical lecture on high frequency amplification was given by Mr. C. Neems-Stanley at a recent meeting of the Tottenham Wireless Society. The lecturer first reviewed the methods in general use for obtaining H.F. amplification prior to the advent of the screened grid valve. Some interesting comparisons were drawn between the efficiency of the early methods as compared with those of to-day. Practical hints were given for the construction of coils for use with modern valves.

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Cutting Out Brookmans Park.

The problem of interference from the new Brookmans Park transmitter was fully dealt with in a lecture at the last meeting of the North Middlesex Radio Society. The speaker, Mr. E. H. Laister, dealt especially with the case of the simple unselective receiver which is in such extensive use at the present time. The use of a loose-coupled circuit was advocated as the simplest and probably most effective modification which could be made, and it became obvious, from the speaker's remarks, that the separation of stations of fairly close wavelengths was not the intricate task that many people imagined. Wave-traps were denounced owing, said the lecturer, to their disconcerting propensity for cutting out the wanted station as well as the unwanted.

Hon. Secretary, Mr. E. H. Laister, "Windflowers," Church Hill, Winchmore Hill, N.21

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BROADCAST BREVITIES

By Our Special Correspondent.

New Test for "B.P." Listeners.—European Programme Exchanges.—Greeting the New Year.

A Mixed Post.

"A spate of letters," to use the vigorous phrase of the B.B.C. Correspondence Department, has occurred in regard to the Brookmans Park twin transmission tests. A few are congratulatory, but the majority are plaintive. Most plaintive of all are those from listeners who wish to know what has become of London's late dance music. Apparently, in spite of the torrent of publicity, there are people unaware of the existence of twin transmission tests!

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Tuning Out Twin Tunes.

The most fruitful cause of complaint is of inability to separate the two transmissions. Sufferers under this head may have further reason for lamentation in a week or two, for I hear that those unobtrusive talks from the 356-metre transmitter are to be replaced by music; European ether searchers know how much more difficult it is to separate two tunes than a tune and a talk.

As I prophesied last week, many of the general public are finding the 261-metre wavelength beyond their technical resources.

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Brookmans Park Uses Wireless Link.

An unpleasant message from the Post Office awaited the B.B.C. engineers when they rolled up for duty at 9 o'clock on the morning of Saturday, December 14th. A technical catastrophe at Holloway had resulted in a complete break in all the five lines which connect Savoy Hill with Brookmans Park. Throughout the day, therefore, the London Regional station had to pick up its material by wireless from Daventry 5XX, which explains the B.B.C.'s polite apology for the unusual amount of atmospherics.

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Europe Makes Merry.

New Continental landlines are to have their first real test on January 3rd, when the B.B.C. will co-operate with the German and Belgian broadcasting authorities in an original "give and take" relay from 8 to 9.15 p.m. The first portion of the programme will come from Cologne, and will consist of Haydn's "Fourth London Symphony." This will be followed by a relay from Brussels of the works of Gretry, and the feature will conclude with a B.B.C. transmission of Henry Purcell's "Fairy Queen."

Listeners in Germany, Belgium and Britain will hear all three portions.

Sunday Education.

Up till now the B.B.C.'s educational campaign has been limited to six days in the week. In 1930 it is to wave its standard on Sundays as well. The transmitter involved will be 5GB, which will send out a talk every Sunday from 5.45 to 6.15 on subjects of interest to students of theology. The speaker will be Dr. E. S. Waterhouse.

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A Programme Quandary.

If Savoy Hill wishes to proclaim the general high standard of programmes there is no better way than to draw attention to the quandary in which it finds itself over National Radio Week. This week of rejoicing begins on Sunday, January 12th, and the original intention was that the B.B.C. should prepare special "star" programmes for the occasion. But the programme people feel that the "star" standard has now been attained with unfailing regularity for months past. How can they improve perfection?

In all seriousness, can anyone suggest a really original feature?

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The Grand Good Night.

For the fifth year in succession the B.B.C. will bid a Grand Good Night to everybody on New Year's Eve, and this time it is hoped that nobody will be forgotten. One year this unique message, for which Mr. J. C. Stobart is responsible, was intended to greet all the great towns and cities of Britain, but Dundee was unintentionally omitted, and Savoy Hill very soon heard about it. Another dreadful omission occurred last year when a greeting to men of all trades and professions left out the firemen.

This year a special greeting will go out to the National Broadcasting Company of America.

AS OTHERS HEAR THEM. Students of broadcast technique at the Berlin School of Music listening to their own microphone efforts by means of a magnetised wire recording instrument.

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"Exit 1929."

The birth of the New Year will be celebrated by the B.B.C. in a radio sequence on December 31st-January 1st. The people of those countries which keep Central European time will hold their festivities one hour in advance of Great Britain. The clocks in Holland, which observe an independent time, will strike midnight approximately twenty minutes before Big Ben. When the Old Year has died in London it will still have five hours of life in New York.

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Celebrating on the Continent.

Hence the programme sequence will be on the following lines:—At 11 p.m. British listeners will hear midnight in Cologne, followed by dance music by Jack Hylton and his Band relayed from the Kit-Cat Restaurant. At 11.10 p.m. the celebrations in Paris, Copenhagen, Hamburg, Vienna, Frankfurt, Buda Pesth, Brussels, Madrid, Milan and Turin will be heard, with more dance music by Jack Hylton's Band. At 11.35 p.m. a relay of the bells of St. Vitus, Hilversum, will usher in midnight in Holland.

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"Good Morning, Everyone."

At 11.50 p.m. the B.B.C.'s own celebration will include a message for 1930 by Canon W. H. Elliott and the singing of the hymn, "O God Our Help in Ages Past," while the bells of St. Michael's, Cornhill, will "ring out the old." The striking of midnight will be relayed from Big Ben, followed by the bells of Southwark Cathedral, rung by the Ancient Society of College Youths. "Auld Lang Syne" will be sung before the lingering sounds of the Old Year are heard from New York. Then comes the Grand Good-night and a closing salutation at approximately 12.10 a.m. of "Good Morning, Everyone."

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This YEAR'S PROGRESS in COMMERCIAL WIRELESS

By Lieut.-Colonel
CHETWODE CRAWLEY,
M.I.E.E.

Privacy in Transatlantic Telephony.—The Radiotelegraph Convention.—Less Broadcast Interference.—Wireless Beacons.

PUBLIC attention has been focused on commercial wireless communications in 1929 as it never has been before, at any rate so far as this country is concerned, with the possible exception of 1913, when the first scheme for Imperial communications, better known under the old halfpenny Press heading of "The Marconi Scandal," was under discussion in the House of Commons. Again the interest has been caused by our Imperial communications, in connection this time with the merging of the cable and wireless interests as a result of the report of the Imperial Wireless and Cable Conference which was published in July, 1928.

It will be remembered that this conference, at which the whole Empire was represented, was appointed to examine the situation which had arisen as a result of the competition of the beam wireless telegraph services with the submarine cable services. The conference recommended that the Government cable and wireless services for Imperial communication be transferred on certain terms to private enterprise, being merged with the Eastern Telegraph and its associated companies and the Marconi Company so as to amalgamate in one commercial undertaking, with a certain amount of Government control, all the cable and wireless interests conducting communications between the various parts of the Empire. These recommendations were accepted by all the Governments concerned, and the Government services were transferred to the merger on the 30th of September last.

This great communication merger, with a capital of over £53,000,000, consists of two new associated companies, the Imperial and International Communications Co., Ltd., which deals with the traffic, and Cables and Wireless, Ltd., which deals with the manufacturing side of the business.

This is the first great combination of cable and wireless interests that has taken place in the world, but during the year similar ideas have taken strong root in the United States of America, and efforts are being made to get rid of the ban imposed by law in that country upon mergers of interests dealing with wire, wireless and cable communications.

Wireless Telephony.

Wireless telephony has been specifically omitted from the British merger, and the British Post Office reserves the right to conduct the external telephone services of Great Britain and makes terms with the company when it uses the company's stations for telephone purposes. So far, no commercial telephone service has been opened on the beam system between England and the Dominions, though several interesting demonstrations took place during the year, notably that of broadcasting the Thanksgiving Service for the recovery of the King on July 7th. The service was transmitted from London to Bodmin by land-line, thence by beam telephone to Montreal, Canada, and again by beam telephone to Sydney, Australia. This service was rebroadcast, and was heard well all over Canada and Australia.

On the same day, and by the same route, conversation was held between England and Australia. This was the first time that duplex telephone conversation had been held between the two countries.

Another interesting experiment in long-distance telephony took place between Sweden and America, including the England-America wireless link. The total length of route traversed was about 14,000 miles, including the wireless link of 3,200 miles; this constitutes a record in distance for telephone communication.

The latest important wireless telephone link on the directive system was opened on October 12th between Spain and the Argentine. This is the longest wireless telephone circuit yet working, but by far the most extensive and important telephone link in the world is the Transatlantic circuit which was originally opened

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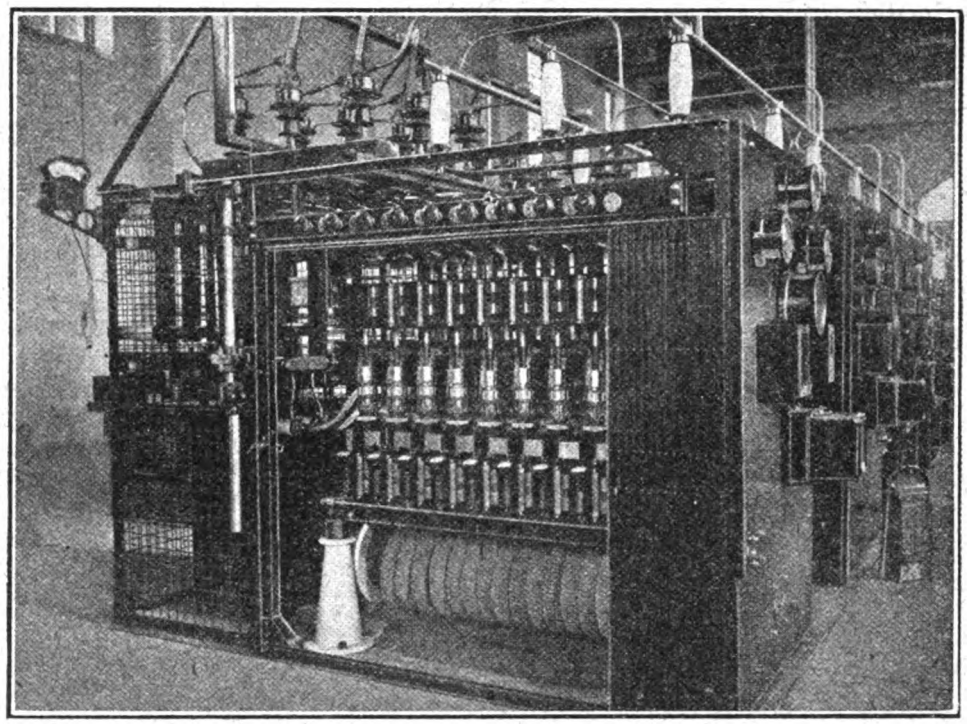
This Year's Progress in Commercial Wireless.—

between London and New York in January, 1927.

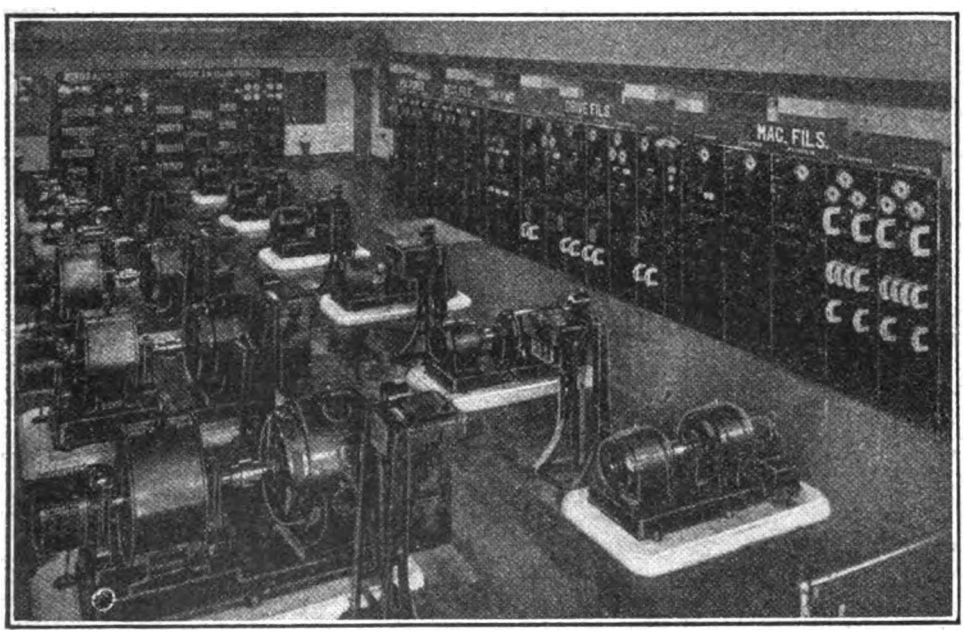
The use made of this Transatlantic wireless telephone circuit has increased considerably during the year, and there are now three short-wave channels working in addition to the long-wave channel. The traffic at present averages about 45 calls per day, the duration of each call being about six minutes. Ninety-five per cent. of the inward traffic comes from the United States, 4 per cent. from Canada and 1 per cent. from Cuba and Mexico. Of the outward traffic, 53 per cent. is from Great Britain, 34 per cent. from France, 7½ per cent. from Germany and 5½ per cent. from other European countries. The circuit suffered from the fact that it was possible to overhear conversations, but methods of imparting a high degree of privacy have recently been developed.



A valve panel at the Rugby station.

Short Waves.

This year has been notable for the almost universal adoption of short waves for long-range wireless telegraph circuits, and probably more new circuits have been opened than in any former year. The volume of traffic dealt with by wireless telegraphy has continued its rapid increase which began when the Imperial beam circuits came into operation three years ago, and by September, when these circuits were transferred to the merger company, they were dealing with some 900,000 words a week with this country.



The machine room, Tetney beam station.

The Radio-Telegraph Convention.

As regards the wireless communications of ships, the most important events of the year were the coming into force on the 1st January of the new International Radio-Telegraph Convention, which resulted from the international conference held in Washington at the end of 1927, and the holding in London in April and May of an international conference on the Safety of Life at Sea.

The most important regulations brought into force by the Convention concerned the distribution of wavelengths amongst

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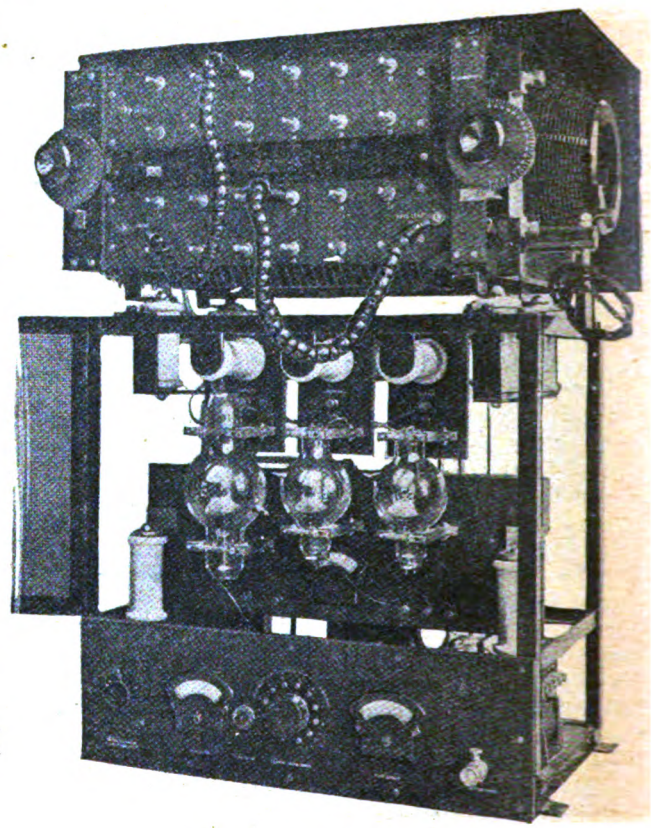
This Year's Progress in Commercial Wireless.— the various services; ships, aircraft, fixed, broadcasting and experimental. The use of the 300- and 450-metre waves, which had been extensively employed by small ships, has been curtailed in the interests of broadcasting, and is now practically abolished. For the same reason, spark sets at coast stations are being replaced by interrupted continuous wave installations, except in the case of very small ships' sets, in accordance with the regulations of the Convention. The qualifications required of ships' operators have been overhauled, and new regulations introduced in connection with distress and similar signals.

This regulation of wireless services throughout the world was long overdue as the provisions of the previous Convention of 1912 were quite inadequate and out of date, but it is surprising how well we had managed to get along since the War on a policy which had nothing behind it but goodwill and common sense.

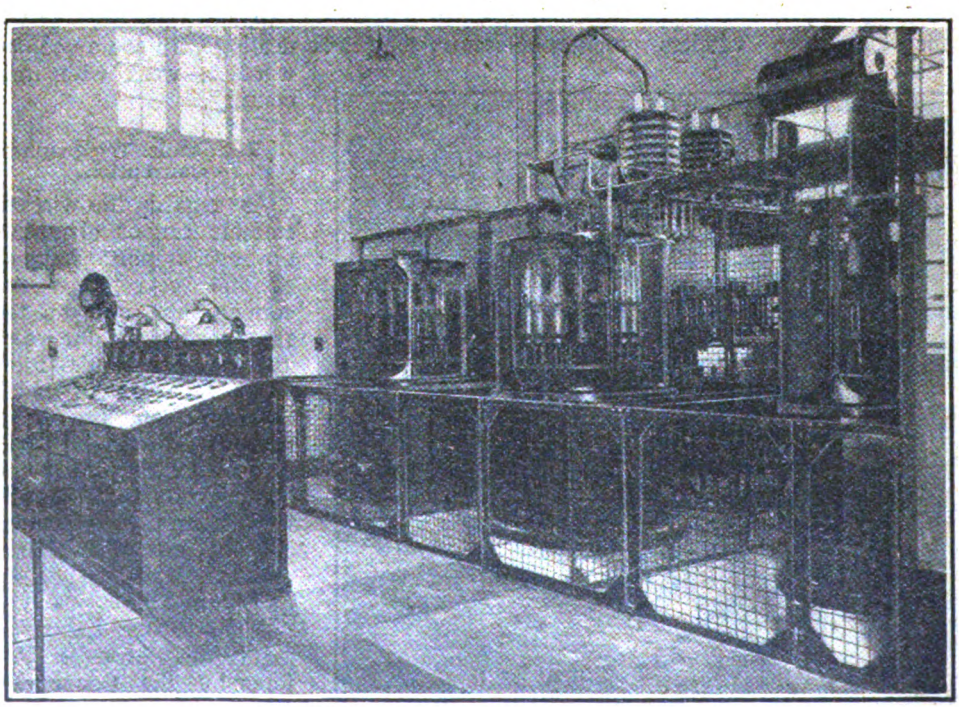
The Safety Convention.

The same might be said of the regulations governing the installation and use of wireless in ships in connection with the safety of life at sea. The only international convention dealing with this aspect of wireless signalling was produced in 1914, but owing to the War was never ratified by any of the countries concerned. Regulations were indeed introduced in this country just after the War on the general lines of those in the Convention, but, on the whole, the regulations in other countries were much less stringent. The new Convention, which will come into full force in 1931, will bring all other maritime countries into line with our present technical regulations, and will introduce several new important rules. For two years before this conference we alone had been using automatic apparatus for the reception of the alarm signal, and it was satisfactory that the conference recognised internationally the practical advantage of this apparatus for keeping a safety watch, and laid down watch-keeping rules for the ships in which it is fitted.

This will be, too, the first Convention to recognise the desirability of fitting directional receivers for safety purposes, and it stipulates that every passenger ship of 5,000 tons gross and upwards shall be provided with approved directional apparatus. The importance of wireless in connection with the dissemination, collection and distribution of meteorological data is fully recognised for the first



A ship's long-range transmitter.



Telephone transmitter, with control table in foreground, at the Rugby station.

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This Year's Progress in Commercial Wireless.—

time, and co-operation between the various Governments with this end in view is arranged for on general lines. The watches to be kept in different classes of ships for safety purposes are also laid down.

Ships' Wireless.

The chief advances made in ship-and-shore signalling apparatus include the substitution of I.C.W. for spark sets in many ships and coast stations, and the continued increase in the number of ships fitted with automatic receivers for the alarm signal and with directional receivers. The number of automatic receivers now fitted in British ships is over 1,000, and the number of directional receivers over 800.

A number of new all-round wireless beacons have been installed at various points on the coast, and a directional beacon from which ships not fitted with directional receivers can obtain bearings has been installed experimentally at Orfordness in Suffolk.

The increase in long-range short-wave sets in ships has been marked. About 80 sets were working throughout the world at the beginning of the year, whereas about 180 are working now.

Wireless telephony, too, is at last beginning to emerge from its long chrysalis state so far as ship communications are concerned. Previously only a very few ships, mostly fishing vessels, were fitted, but during the last few months some of the large liners have been fitted, and experiments with short-wave telephony with the object of a commercial service are now in hand. In Germany a commercial service connecting with the telephone system of the country is being tried experimentally with some small ships. A few lifeboats have been fitted with wireless telephony for the first time during the year.

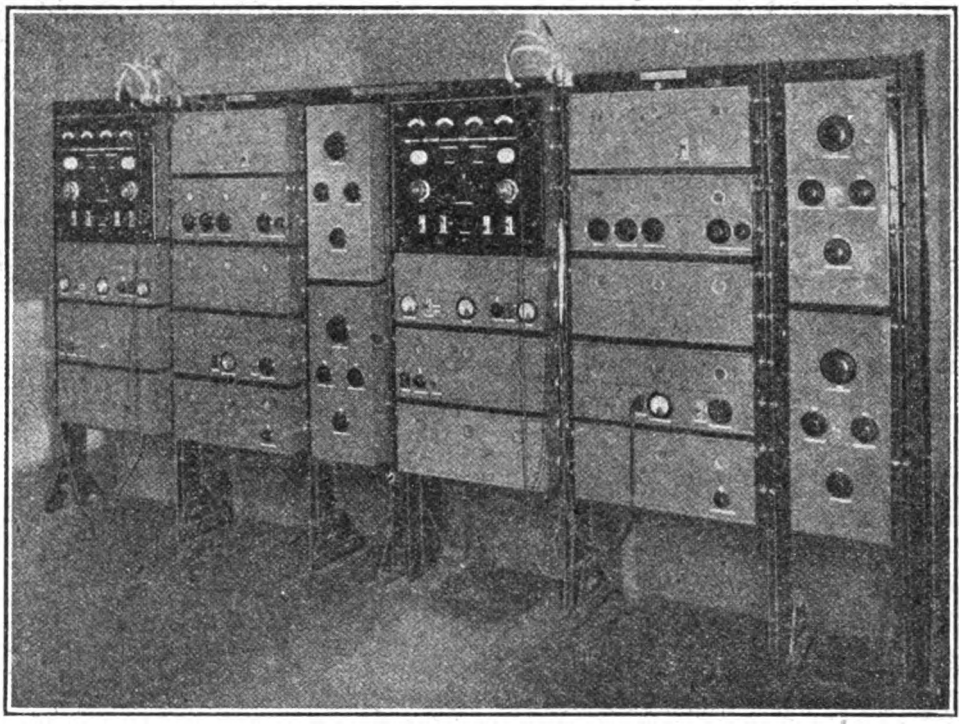
Experiments have been carried out with the facsimile transmission of weather charts to ships, but no commercial service has yet been commenced.

The Hague Conference.

This last year has been notable for international regulations for the control of wireless communications, as in addition to the coming into force of the International Radio-Telegraph Convention of Washington, and the holding of the international conference for the safety of life at sea in London, there was held an international conference in Prague for the regulation of broadcasting services, and an international conference at the Hague to advise on various technical matters which had arisen out of the regulations framed by the Washington Conference.

The Prague Plan for the international regulation of broadcasting wavelengths is rather outside commercial wireless, and has been already fully dealt with in this journal, but we might glance at some of the principal recommendations of the Hague Conference.

Most of the recommendations referred to methods of measurement, and technical problems which require further study. The terms long and short waves have always given rise to a certain amount of confusion, and the conference recommended that waves be classified as follows: Below 100 kcs. (over 3,000 metres), long waves; 1,500 to 100 kcs. (200 to 3,000 metres), medium waves; 6,000 to 1,500 kcs. (50 to 200 metres), intermediate waves; 30,000 to 6,000 kcs. (10 to 50 metres), short waves; above 30,000 kcs. (below 10 metres), very short waves. Waves between 50 and 13 metres are to be reserved in principle for long distances, 50 to 85 metres for moderate distances, 85 to 200 for the shorter distances.



The Indian and Australian receivers at the Skegness beam station.

It was agreed that in practice a separation of 0.1 per cent. frequency is desirable to avoid interference. This is the great problem which confronts the development of wireless communication, viz., how is it possible to crowd into the ether, without causing mutual interference, a sufficient number of waves to meet the demand? As the year closes, claims are being made that a new method has been devised to deal with this problem, but we must wait for next year to see how far these claims are justified.

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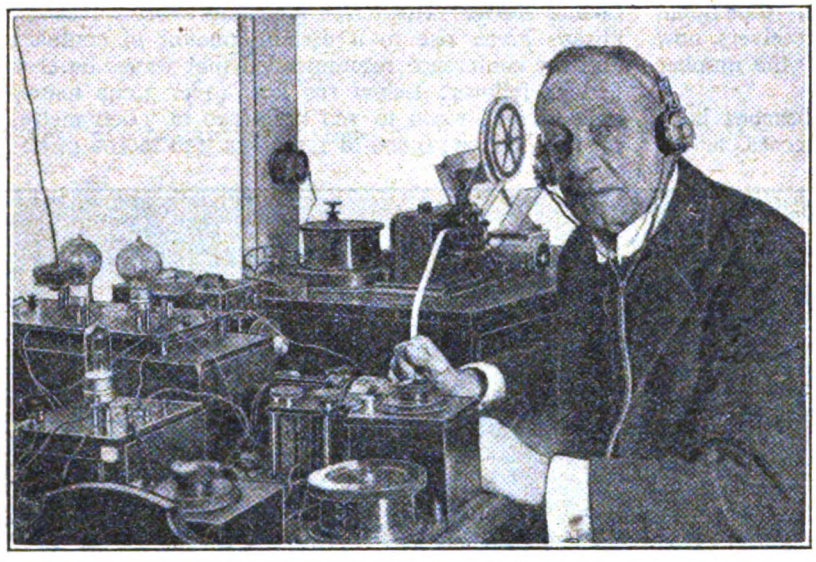
A WIRELESS PIONEER.

The Late Admiral Sir Henry Jackson.

THE world of wireless has lost one of its most notable personalities by the death, on December 14th, of Admiral of the Fleet Sir Henry Bradwardine Jackson, G.C.B., K.C.V.O., F.R.S., D.Sc., M.I.E.E. A career of distinguished naval service, culminating in an appointment to the highest rank during the War, would in itself provide the material for an engrossing biography, but it is the late Admiral's untiring devotion to the cause of wireless from the earliest days which must appeal to every amateur and experimenter.



The late Admiral Sir Henry Jackson in his wireless laboratory. This photograph was taken soon after the war.

Born at Barnsley on January 21st, 1855, Henry Bradwardine Jackson entered the Navy in 1868. After service abroad he joined the torpedo school ship *Vernon* in 1881 and quickly demonstrated those scientific talents which were later to be applied to the study of Hertzian waves. It was in 1893 that Sir Henry, while commanding the *Edinburgh*, conceived the idea of utilising electro-magnetic waves for signalling purposes. His experiments principally consisted of exciting a circuit which included a filings coherer tapped by the hammer of a high-resistance trembling bell. In 1896 Sir Henry met the young Marconi, and the two collaborated in experiments, which finally proved to a reluctant Admiralty Signals Committee that wireless was to supersede all other methods of communication at sea.

Sir Henry Jackson remained responsible for the progress of wireless telegraphy in the Navy until 1906, when he became a Rear-Admiral. Lord Fisher had already recognised his special scientific ability by selecting him, in 1905, for the office of Third Sea Lord and Controller of the Navy. A spell of service afloat was followed by an Admiralty appointment, and when, in 1915, Lord Fisher left the Admiralty, Sir Henry was appointed First Sea Lord. In December, 1916, after rendering invaluable service, he retired from this post; he was promoted G.C.B. in the same year, and on July 31, 1919, was advanced to the rank of Admiral of the Fleet. In 1920 he was appointed Chairman of the Radio Research Board. He retired from the Navy in July, 1924.

The late Admiral, who always showed a deep interest in amateur experimental research, in 1922 occupied the Presidential Chair of the then Wireless Society of London and was a frequent figure at the meetings of the Radio Society of Great Britain. Sir Henry was elected a Fellow of the Royal Society in 1901. He was a member of the Institute of Electrical Engineers, Hon. D.Sc. of Oxford and Leeds, and Hon. LL.D. of Cambridge.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

THE "STENODE RADIOSTAT."

Sir,—The brief description of the action of the Robinson "Stenode Radiostat," given in your current issue, appears to me to carry one rather farther in the explanation of the apparently paradoxical performance of this device than is indicated in the article in question. I refer to the words: "The above explanation certainly discloses an ingenious method by which ringing might be prevented on a set of high selectivity, but it certainly does *not* explain why the sidebands in broadcast transmission get through on such a set." Is this not rather a contradiction?

For convenience modulation is thought of in terms of sideband frequencies, the principal reason being that the system used for obtaining selectivity invariably employed in present practice is a resonant circuit, which has the property of becoming more and more slow to respond to changes of applied e.m.f. by corresponding changes of current, as the selectivity is increased by reducing the damping. But I see no prima facie reason why this should be an inherent property of all selective systems. Thus, if a telephony transmission is regarded as an oscillation of constant frequency and variable amplitude, the ordinary tuned circuit, if made so selective as to respond substantially only to this single frequency, must necessarily be of such low damping that the variations in the amplitude of the signal e.m.f. are not matched by corresponding variations in the current

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in the circuit (and corresponding e.m.f. available for operating the receiver). In other words, the modulation is cut off, leaving only the carrier. The high modulation frequencies obviously suffer first.

On the other hand, if Dr. Robinson has been able to produce a highly selective system which is able to respond to changes in amplitude at audio frequencies (and why should he not?), it is obvious that it would have the properties claimed for the "Radiostat."

This conclusion is arrived at without assuming any knowledge of Dr. Robinson's system, or any fallacy in existing theory, but simply by discarding the popular but unwarrantable assumption that all selective systems must have the same properties as the particular one commonly used.

Lee, S.E.12. M. G. SCROGGIE, B.Sc., A.M.I.E.E.

Sir,—I was interested in your description of the above, and venture to give an explanation of how it was possible to receive the sidebands up to 5 kilo-cycles and yet eliminate an interference frequency difference of 1 kilo-cycle.

It is well known that a tuned circuit is not symmetrical about the point of tune. For example, the response to a frequency, say, 1 kc. below the resonant frequency is less than the response 1 kc. above. This difference is far more marked on longwave-tuned circuits such as the intermediate stages of a superhet., and when several stages are used the effect is greatly increased. The result is to give a superhet. a response curve extremely steep on the lower side and a more gradual falling off on the other side.

With such a tuning curve it is possible to tune in the signals in such a way that the carrier frequency and one sideband only is received. If then the interference frequency is such that it comes within the sideband which is dropped, it will not be apparent in the audio-frequency output.

With regard to the low-resistance circuit, your implication that such remains selective when frequencies are applied for an exceedingly short time, does not seem correct.

An example is the super-regenerative receiver in which, when actually receiving and amplifying, the resonant circuit has negative resistance.

Yet such receivers are very unselective.

Sheffield. R. E. RAYNER.

Sir,—Re the Robinson "Stenode Radiostat" described in the December 11th issue of *The Wireless World*, it appears that the chopping up of the signal to neutralise the lag of a H.F. circuit is enough to explain the result described. This is because the H.F. circuit does not amplify the higher frequency modulation when the lag is present, and it appears that the sidebands have no objective existence, but are obtained by Fournier Series only. So that when the lag is eliminated, the circuit may be made as selective as possible. R. SUGDEN.

London, W.11.

OURSELVES.

Sir,—I can only crave your pardon for taking up your valuable time with this letter—let its subject matter be at once its excuse and its justification.

It was with pain and indignation that I read in your Editorial views in to-day's issue the criticism of Mr. Brown, of South Norwood, of your policy in increasing the price of your paper, and I feel so keenly the attitude of this gentleman that I cannot resist writing to express my resentment.

How puerile are Mr. Brown's ideas! Does he not, for example, give any thought to the fact that although he may be able to obtain technical advice from the manufacturers of components (I have not been similarly fortunate!) the replies published each week to readers' queries are absolutely invaluable *to others who have exactly similar problems*? I could mention numbers of instances where I have been helped by these published replies. Does not Mr. Brown further realise that successful wireless reception can *only* be obtained by most careful quantitative analysis and experiment? And where will he obtain such technical articles, by such experts in this most technical of all subjects, except in your paper?

There is a stage which we amateurs reach at which we begin to realise how little we know, and how extraordinarily efficient your contributors are. It is at that stage that we appreciate the fact that your paper is the *only* one which will help us. Were you to double or even treble the price of *The Wireless World* it would still be cheap by comparison with the quality of its technical articles.

Perhaps you will kindly accept seasonable greetings from a staunch supporter. H. D. McCLENAGHAN.

Dublin.

Sir,—I beg to point out that my letter has been misquoted in your Editorial. I said "the bulk of the queries that you receive could no doubt be accurately replied to *by the mechanic or draughtsman in the experimental workshop.*"

Fair play, please! Thanks for your letter.

South Norwood. E. H. BROWN.

The complete sentence in Mr. Brown's original letter read: "The bulk of the queries that you receive could, no doubt, be accurately replied to by the mechanic or draughtsman in the experimental workshop. The rest you can refer to the component manufacturers, who are only too pleased to give technical information, as I have often proved."

It is regretted that in our editorial we misquoted Mr. Brown by implying that he proposed "the bulk of the queries" should be referred to manufacturers instead of "the rest."—ED.

BOOKS RECEIVED.

Electrical Wiring and Contracting. Edited by H. Marryat, M.I.Mech.E. Parts 2 to 4, which complete the first volume, include drawing—with useful illustrations indicating the generally accepted symbols used in electrical diagrams and the conventional section lining to denote various materials—electricity and magnetism, A.C. work and index to Vol. I

Parts 5 to 8, which comprise Vol. II, include D.C. and A.C. generators and motors, testing and measuring instruments, wires and cables, also a section on mathematics as applied to wiring and contracting.

Each part pp. 64, with numerous diagrams and illustrations. Published by Sir Isaac Pitman and Sons, Ltd., London. Price 1s. per part

A general notice of this publication and the contents of Part I appeared in our issue of October 23rd, page 474.

Radio Traffic Manual and Operating Regulations, by R. L. Duncan and C. E. Drew. A handbook primarily intended for the use of operators and amateur transmitters in U.S.A. and comprising instruction in Morse, operating rules and regulations of the Radio Marine Corporation of America, International Radiotelegraph Convention of Washington and the Regulations attached thereto, U.S. Radio Act of 1927, Ship Act of July 23rd, 1912, and regulations governing the issue and renewal of operators' licences in U.S.A. Pp. 187, with 15 illustrations, examples of operators' abstracts, logs, etc. Published by J. Wiley and Sons, Inc., New York, and sold by Chapman and Hall, Ltd., London. Price 10s. net.

Handbook for Wireless Telegraph Operators (Revised 1929), issued by the G.P.O. The principal additional matter in this revised edition relates to the classification of Radiotelegrams, especially those in code or cypher, and the charges for five-letter code words. Published by H.M. Stationery Office. Price 6d. net.

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Modern Gramophones and Electrical Reproducers, by P. Wilson, M.A., and G. W. Webb, with a foreword by Compton Mackenzie.

A comprehensive text-book on the theory and practice of gramophone construction and the various problems involved in the recording and reproduction of sound. Pp. 272+xvi, with 116 illustrations and diagrams.

Published by Cassell and Co., Ltd., London, price 10s. 6d. net.

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READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Uncontrollable Oscillation.

I have just completed construction of a detector-2 L.F. receiver, using a commercial two-range tuner which includes a reaction winding. So far, results have been disappointing; on the medium waveband, uncontrollable oscillation is produced unless the reaction control condenser is disconnected. On the long-wave side, it is impossible to stop oscillation even in this way unless H.T. voltage is reduced to a ridiculously low value. Can you tell me how to put matters right?

H. G. S.

It seems that the tuning unit is designed for a small reaction condenser having a lower minimum value than that of the condenser you are using; this would account for the behaviour of the set on the medium band, while H.F. choke resonance is probably responsible for the trouble on the long waves.

Removal of a few turns from the reaction winding (or windings), combined with the substitution of another choke for the existing component, would almost certainly effect a cure, but we think that your best plan is to try the effect of connecting a small fixed condenser (of about 0.0001 mfd. or even 0.0002 mfd.) between anode and negative filament terminals of the detector valve. This addition will almost certainly overcome the tendency towards uncontrollable self-oscillation, and will improve detector efficiency—probably to a very noticeable extent. The addition of this capacity may possible modify the frequency characteristics of the L.F. amplifier, but is hardly likely to do any harm.

c c o o

Where D.C. Resistance is Unimportant.

I am going to make up a small battery eliminator (to work on my A.C. supply) for providing grid bias potentials for a large amplifier. Will you tell me if the primary and secondary winding of a disused L.F. transformer are likely to be satisfactory for smoothing purposes in this piece of apparatus, or would it be safest to order a special choke? Of course, the windings will be joined in series.

G. H. C.

There is no reason why the windings of a reasonably good L.F. transformer should not be quite satisfactory for this purpose. Their ohmic resistance is likely to be considerable, but it should be an easy matter to ensure that this value will be low compared with that of the potentiometer across which the biasing potentials are developed.

c o o o

The Baby Alarm.

Please do not consign this letter to the waste-paper basket before reading it through: my query is a perfectly serious one, and I am emboldened to ask it as I seem to remember that a similar problem was treated in your pages some years ago.

Now for the question. Is it possible to install a microphone over a baby's cot in a distant room, and to connect the instrument to a receiver so that the child's cries will be superimposed on the broadcast programme? My set is an H.F.-det.-L.F. combination, with grid detection and transformer coupling: if this addition can be made to it, will you please show me how to proceed? T. S. W.

You need have no fear that your query will be treated as frivolous; hardly a week goes by without our receiving a request for information on this subject. Many harassed parents seem to feel a very real need for means of knowing that all goes well with their slumbering progeny while they themselves are listening to the evening programmes.

Fortunately, it is by no means difficult to arrange that any sounds indicative of untoward happenings in the child's bedroom may be amplified by the set and heard through the loud speaker. As a rule, at least two magnifying stages are necessary, so in your case the detector valve must be made to amplify: rectification will, of course, introduce distortion, but this should not matter.

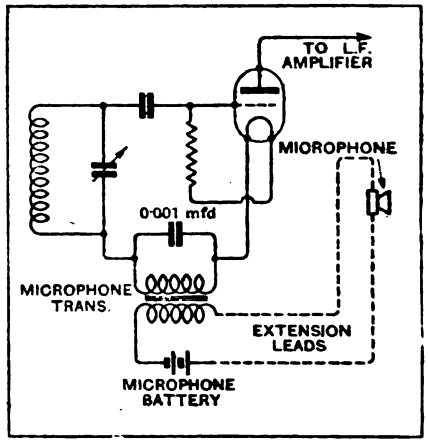

Fig. 1.—Where distortion can be tolerated, the detector valve may be made to work as an extra amplifier in a microphone circuit.

The secondary winding of a microphone transformer is inserted in the grid return lead of the detector valve in the manner shown in Fig 1, and should be shunted by a fairly large H.F. by-pass condenser. Connection is made between the transformer primary and the distant microphone through extension leads, a small battery being interposed; very often it is possible to use the receiver L.T. cells for this purpose. Some method of breaking the microphone circuit must be provided to prevent waste of battery current.

Microphone and transformer should be obtained from the same source, and it is desirable that these pieces of apparatus should be designed for working together.

May we express the wish that you will have no cause to test the functioning of the apparatus during the Christmas festivities?

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components, such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

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ALTERNATIVE PROGRAMME RECEIVER

4D

The Wireless World

AND RADIO REVIEW

The Paper for Every Wireless Amateur

Wednesday, December 25th, 1929.

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BURTON

SELF-LOCATING VALVE HOLDER 1/- each

Pentode -Valve- Holders 1 6 each

Patent No. 316708

MANUFACTURED BY C. F. & H. BURTON

PROGRESS WORKS WALSALL, ENG.

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L.F. TRANSFORMERS

Radio's Choice

Have acquired a world-wide reputation for Quality and Value.

Built by Specialists in Transformer construction, they have set a Quality of Performance above reproach. Your Set will work better with a Telsen Transformer - - - - Fit one now!

RADIOGRAND 12/6

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Radio sets operated by the factory-made double linen diaphragm speaker possess high selectivity at audible frequencies, reproducing with brilliance, with virility, and with the vital temperament of individual instruments and voices.

Cabinet Types from £3.19.6. Chassis Types from £2.2.0. Demonstrated and sold by all dealers.

ULTRA AIR CHROME SPEAKER

with the double linen diaphragm

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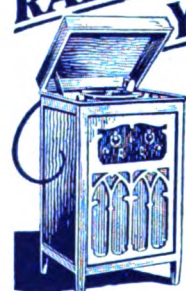

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FOR BATTERY OR MAINS OPERATION

The CRAIGWEIL RADIO-GRAMOPHONE

Write for Particulars The British Radio Gramophone Co Ltd. 77, City Road, London E.C.1

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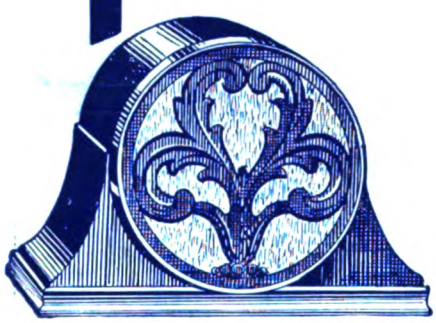

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Complete with flexible lead.

"BEAM" SPEAKERS are constructed to give the finest possible reproduction on either weak or strong reception. The model illustrated is marvellous value, of excellent appearance, and harmonizes with all home surroundings.

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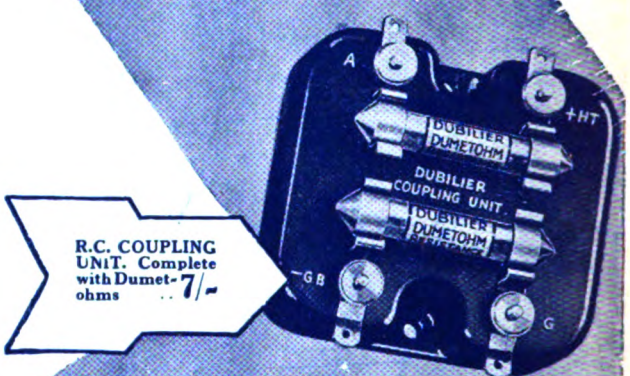

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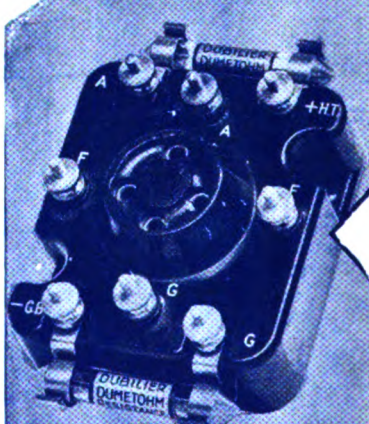

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H.F. CHOKE. Four Types to meet all uses. Each 4/6

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BC 251/C

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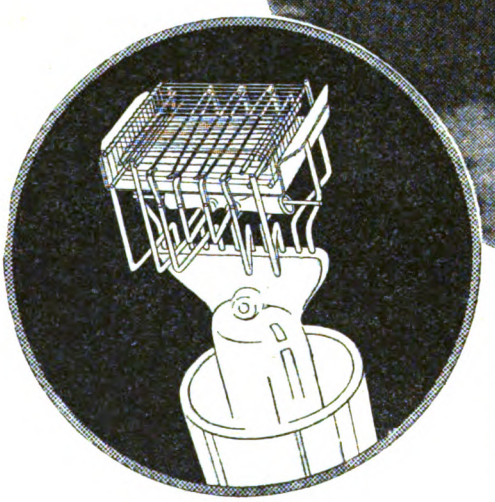
PERFORMANCE PROVES THE P.M. FILAMENT—



— that's how the enormous development and research on the P.M. principle can make itself known to you — through the results you obtain from your receiver with Mullard valves. Such technical improvements on the P.M. filament as —

- ★ **Increased Emission**
- ★ **Greater Efficiency**
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mean incisive reception and vivid tonal purity. Act on this tangible evidence and plug a set of Mullard radio valves into your receiver to-day.

Mullard
THE·MASTER·VALVE

Advt. THE MULLARD WIRELESS SERVICE CO., LTD., Mullard House, Charing Cross Road, London, W.C.2.

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ARE YOU PROUD OF YOUR NEW SET? DO IT JUSTICE AND FIT THE BEST POSSIBLE BATTERY

Grosvenor Batteries give continuous and satisfactory service because they incorporate a new vitalising element which is unique to Grosvenor.

66 v. from 7/6
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Super Capacity for Multi-Valve Sets - - - { 66 v. 20/- / 99 v. 32/6

The **Grosvenor Battery**

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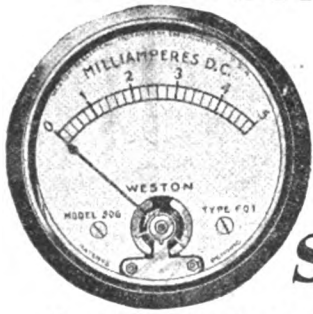

Our Model 506 MIL-AMMETER Panel Mounting type should be placed in the High Tension Circuit of the valve to ensure correct operation and to check distortion.

Prices £1 : 15 : 0—£2 : 15 : 0.

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Pioneers since 1888
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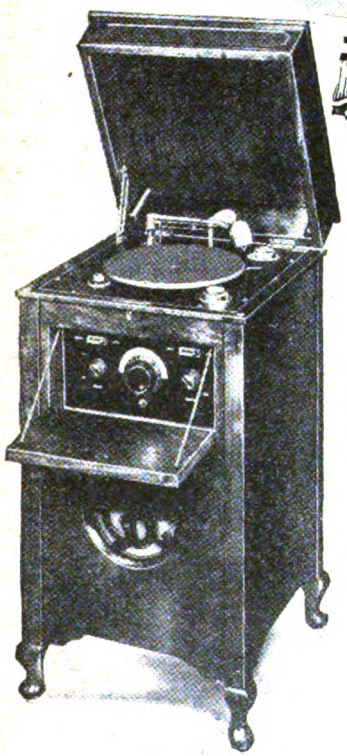
The MIRROR of MUSIC and SPEECH

The croon of the Saxophone—the beat of the drum—the trill of the violin and the ring of the harp—all are faithfully reflected by the "CLARITH" Reproducer.



LIFE — sheer life — colour—movement in music and speech are faithfully reproduced by the "CLARITH," just as the mirror reproduces the form, colour, and movement of that which is before it.

We cannot convey to you in mere words the quality and richness of this Radio Gramophone—you must hear to believe. No batteries to run down—no expense of charging accumulators—just plug in to the lighting socket and the "CLARITH" is working.

Either Record or Radio, a switch changes over. The same volume control is used for both.

The Radio Set embodies a 3-valve circuit of unusual merit —and it brings in the stations. The same specially designed Moving Coil Speaker is used for the Radio Set and the Gramophone, which is also electrically operated—the reproduction is "mirror clear."

The Cabinets used in the "CLARITH" are masterpieces of the craftsman's art and are supplied in Oak, Walnut and Mahogany. These Cabinets enhance the appearance of any home.

Price A.C. 49 Guineas.
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Send To-day for Illustrated Catalogue, Post Free.

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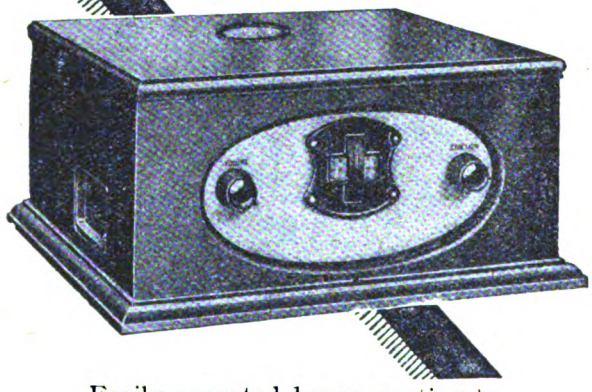

Easily operated by connecting to any A.C. Mains light socket—no batteries needed—this Lotus All Electric 3 valve S.G.P. Set is highly selective and covers a good range of British and Continental stations.

CASH PRICE £21

(Royalties paid and including valves) or £1 19s. 9d. down and eleven similar monthly payments. See and hear it at any wireless dealer's or write for the Lotus Sets catalogue and Hire Purchase terms.

LOTUS ALL ELECTRIC RECEIVER

Gets the best reception.

Made by the makers of the famous Lotus components in one of the most modern radio factories in Great Britain.

GARNETT WHITELEY & CO., LTD., Dept. W.W.4,
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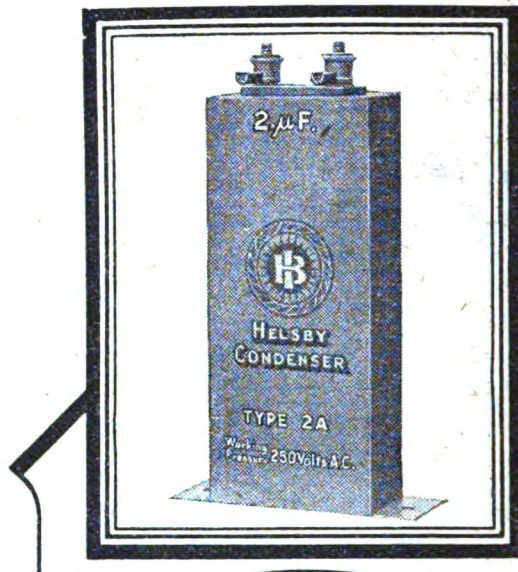
Causton



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You cannot afford to use any but the best Condenser in an eliminator circuit.

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are made and guaranteed by a firm with 30 years' experience in condenser making, from small telephone and radio condensers to Power Condensers weighing upwards of 2 tons.

Guaranteed working voltages :-

Type M	– –	150 volts D.C.
Type 2A	– –	350 volts D.C.
Type 3A	– –	450 volts D.C.
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All Helsby Condensers are vacuum dried and impregnated with a special non-hygroscopic material which renders them moisture proof.

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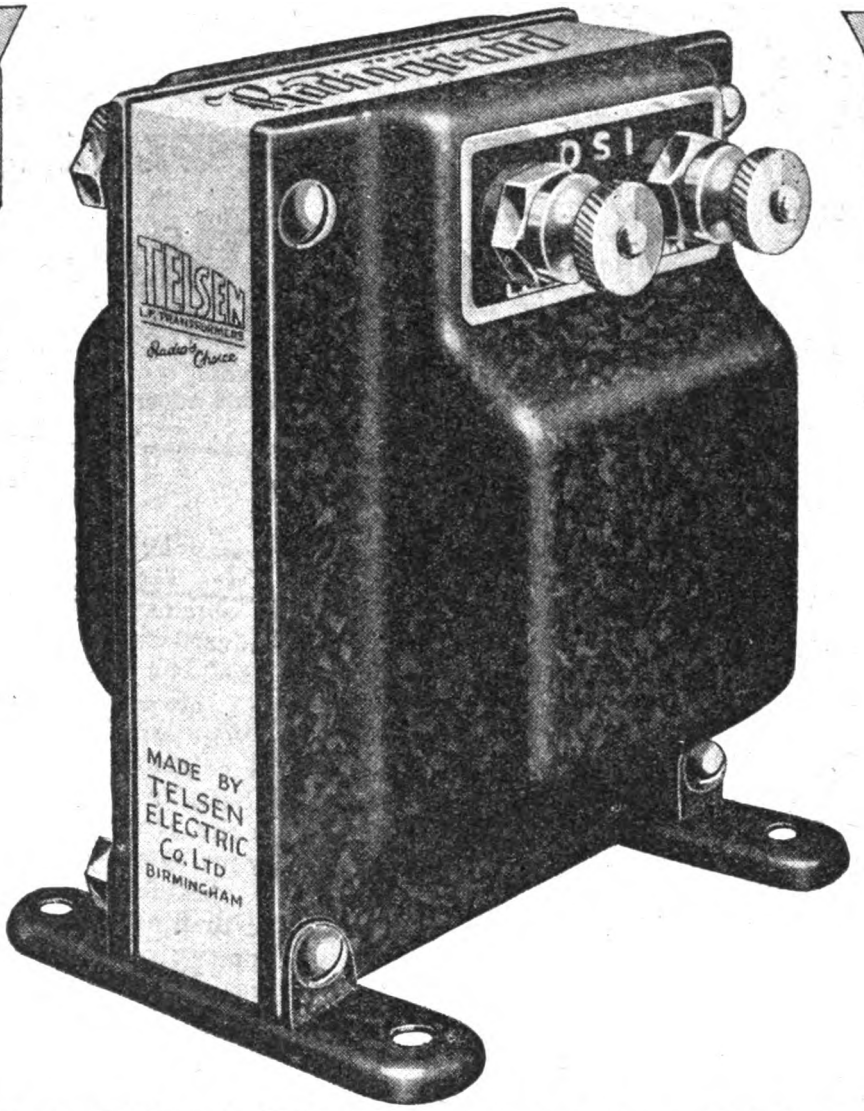

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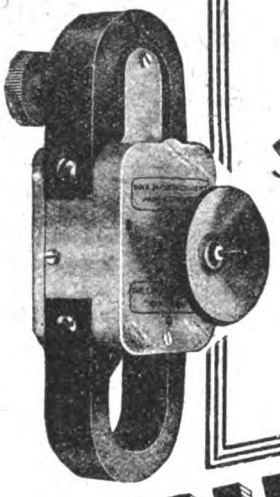

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"Gents,

Have fixed the KUKOO L.S. (Baffle Board 36) and have *obtained absolutely Moving Coil results.* Wonderful. Thanks."

Yours, etc.,
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We understand the above results were obtained on a Mullard Master Three set, with 120 H.T. Mr. Prendergast is in no way connected with us, neither is he known to us.

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COMPLETE SETS

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Read this letter from a recent advertiser!

Dec. 2nd, 1929.

Dear Sirs,

You may be interested to hear that I was very pleased with the results obtained through the half page advertisement I recently inserted in "The Wireless World."

I had always understood that "The Wireless World" was not a good medium for advertising complete Sets, and I must admit that this is the reason why I have not used your space before.

It is therefore very illuminating to find that, although my half page was for two Portables only and one of these a very high priced instrument, I received a large number of enquiries every day for at least 10 days from all parts of the Country.

I can definitely credit "The Wireless World" with these enquiries, as the cheaper Portable was advertised for the first time, and no one could have known of its existence from any other source.

I may say I have entirely changed my opinion regarding your paper now, and will certainly avail myself of its pages in the future.

Yours truly,
(Signed) C. HOLT.

EMPIRE ELECTRIC CO.,
10, Fitzroy Street, London, W.1.

Full particulars of advertising in "The Wireless World," and Advertisement Tariff, will be sent on request.

ILIFFE & SONS LTD.,
DORSET HOUSE, TUDOR STREET, LONDON, E.C.4.

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WISE WIRELESS USERS PREFER BATTERIES

BECAUSE—

pure H.T. current comes only from a dry battery, for it contains steady, direct current and does not depend upon humming generators for its source of supply.

Batteries are handy, portable and safe, too; and cheaper in the long run—no expensive valves or windings to burn out.

Buy a battery and get the best in EVER READY, the battery that has stood the test for 25 years.

Use an EVER READY refill battery for your Electric Hand Lamp.

The Popular Batteries for Portable Sets.

PORTABLE 1. 63 volts, 6×5×3". 8/6

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EVER READY

REGD TRADE MARK

BRITAIN'S BEST BATTERIES

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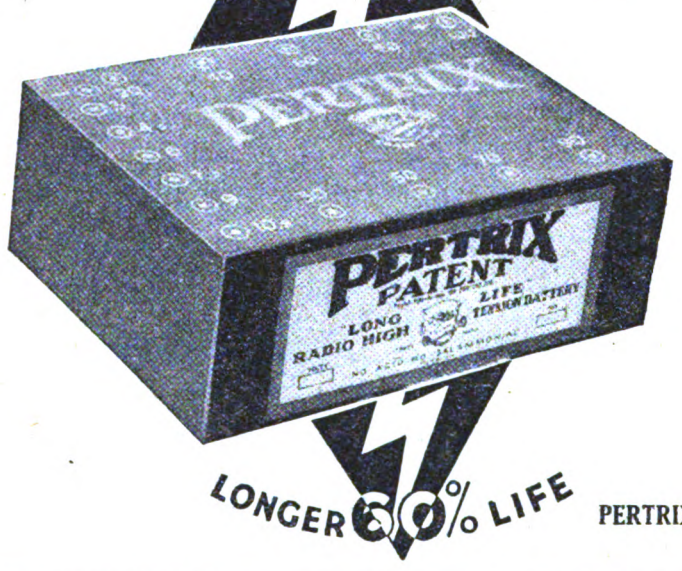

ALL SAL-AMMONIAC batteries develop "crackle" sooner or later. "Pertrix" cannot, for it contains no cell-corroding electrolyte—and in this respect "*Pertrix*" *is unique.* On every test, "Pertrix" shows 60% longer life, and *no loss of power when out of circuit.* Try "Pertrix" once, and you will never go back to the sal-ammoniac type again.

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SUPER LIFE H.T. BATTERIES

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IN THE NEW YEAR

Whatever new components you use for your 1930 set you will not go far wrong with a Trolitax panel.

Trolitax has already proved itself to be thoroughly reliable, and with its high insulating properties and its ease of working it is the ideal panel material. Your wireless dealer stocks Trolitax in a variety of finishes which can be cut to any size required.

Ask to see the range of wood finishes.

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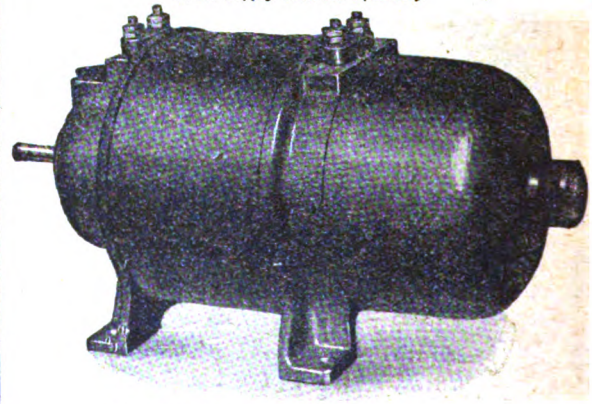
40 WATT Model £13-0-0 **85 WATT Model £19-0-0**

Power Supply Units our Speciality.



IF YOU ARE ON D.C. MAINS employ the above machine for running your ALL ELECTRIC RECEIVER. The only safe way to operate receivers from D.C. Mains. Suitable for well-known makes of Receivers

M-L MAGNETO SYND. Ltd., Radio Dept., COVENTRY.
Telephone: 5001.

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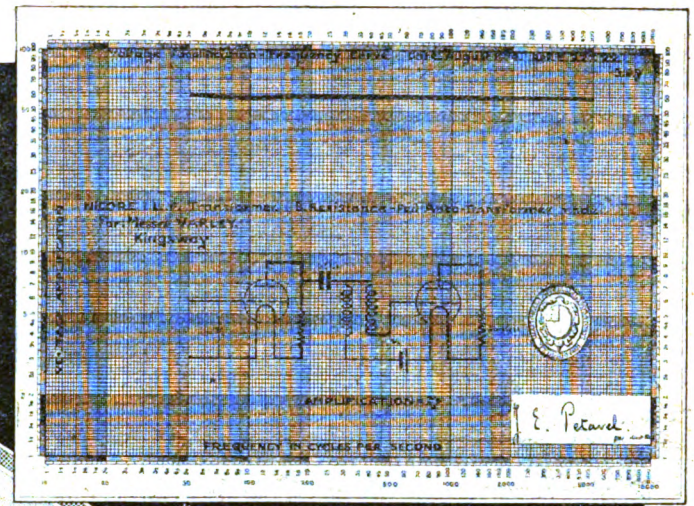
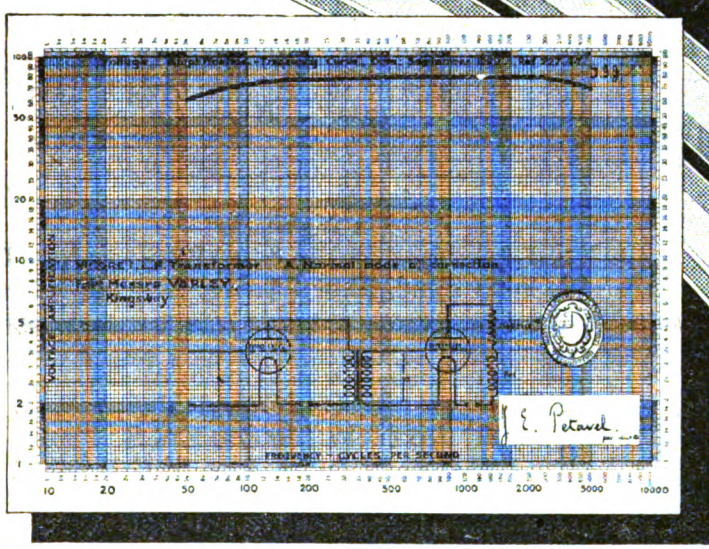
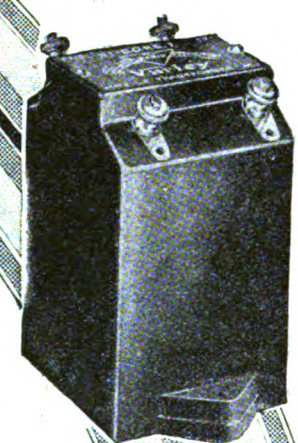
VARLEY
Maintain the lead in L.F. Intervalve Transformers!







You have only to look at these curves to see that for yourself. They show what the curves of no other transformer can show—perfect amplification of the deep bass notes, together with constant response at all frequencies from 50 to 5,000 cycles. These curves have been taken using ordinary valves. If the curves were taken with A.C. Valves, then naturally a much better performance would be apparent. As, however, the majority of constructors have not facilities for using A.C. Valves, obviously it is of far more general interest to publish N.P.L. Curves obtained with the valves which are in almost universal use to-day. Curve "A" is that of Nicore I, used in the ordinary transformer arrangement, showing an amplification of the order of 80 between 100 and 5,000 cycles and over 60 at 50 cycles. Curve "B" is that of Nicore I used in the resistance feed auto-transformer arrangement, showing an amplification of 60 and a perfectly straight line between 50 and 5,000 cycles. No attempt has been made to retain inaudible side-band frequencies; the discerning public will not be slow to realise that our efforts have produced curves which are—like everything else connected with Varley—perfectly straight.

Write for Section D of the Varley Catalogue.

Nicore I (List No. D.P.1) Ratio 4 : 1 £1

For RADIO
OLIVER PELL MANUFACTURE
Varley

Advertisement of Oliver Pell Control Ltd., Kingsway House, 103, Kingsway, London, W.C.2. Telephone : Holborn 5303.

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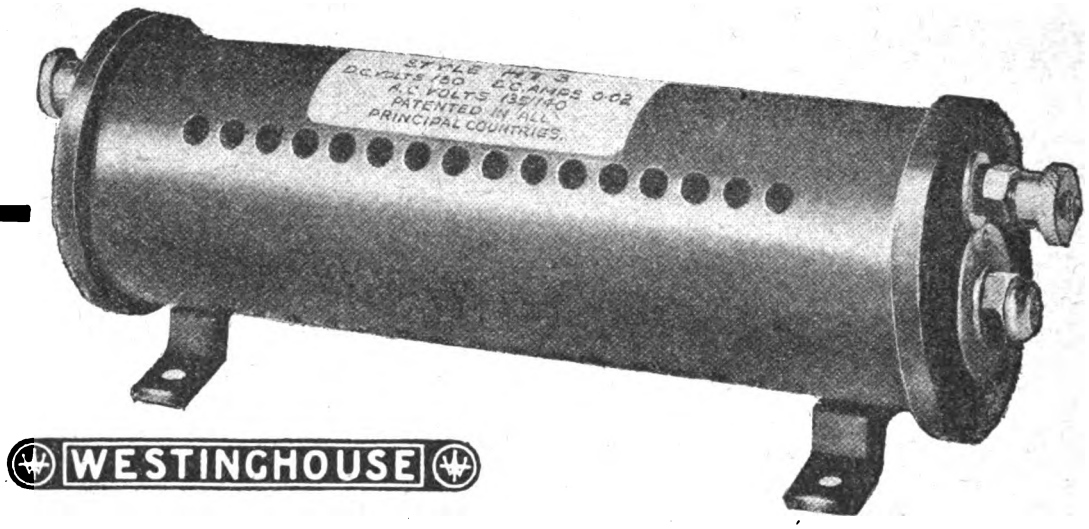

WESTINGHOUSE

METAL RECTIFIER
STYLE H.T 3
FOR HIGH TENSION
D.C. OUTPUT 120 V., 20 M.A.

Price 21/-

Full details and circuits for this unit, and our other types, are given in our 32-page booklet "The All Metal Way—1930." If you are interested in A.C. mains units, you should have a copy.

Send a 2d. stamp with your name and address.

Made in England by:—
The WESTINGHOUSE BRAKE & SAXBY SIGNAL Co. Ltd.
——82, York Road, King's Cross, London, N.1——

Master Your Volume

Write for a copy of the Centralab Circuit Booklet, it's free on request.

Do you realise that by detuning your receiver or dimming your filaments you are adopting hopelessly inefficient methods to control your volume? Such practice results in poor quality and is liable to cause unnecessary interference from other stations transmitting on nearby wave lengths. Centralab Modulator plugs obviate all these difficulties and enable you to control your volume from a mere whisper to full loud speaker strength without spoiling reception.

Just connect the two cords on the Centralab Modulator to your loud speaker terminals and then connect your loud speaker cord tips into the two receptacles in the side of the modulator. You can then master your volume by just turning the small bakelite knob on top of the modulator plug. If your set is equipped with an output jack there is another model modulator plug to suit.

No. 2 type for sets with terminals for loud speakers - - **10/6 each**
No. 1 type for sets with jack for loud speakers - - - **10/6 each**
No. 3 type has a 2 foot cord which enables you to control your volume from your armchair - - - - **12/6 each**

Centralab

The Rothermel Corporation Ltd.
24/26, Maddox St., London, W.1. **'Phone: Mayfair 0578/9.**

DICTIONARY of WIRELESS TECHNICAL TERMS

Compiled by S. O. Pearson, B.Sc.

Issued in conjunction with "THE WIRELESS WORLD."

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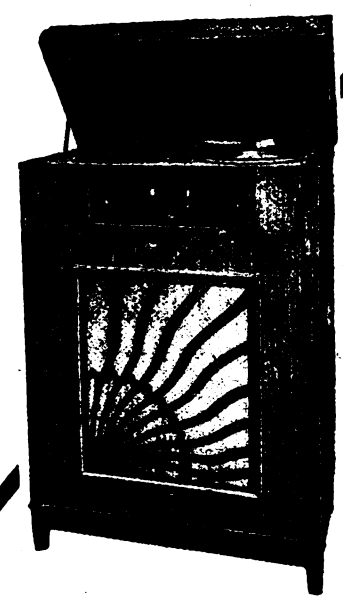

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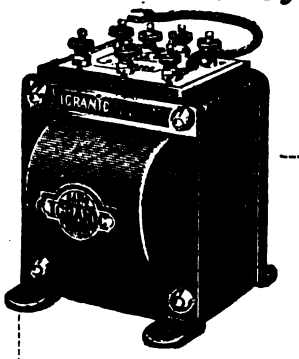

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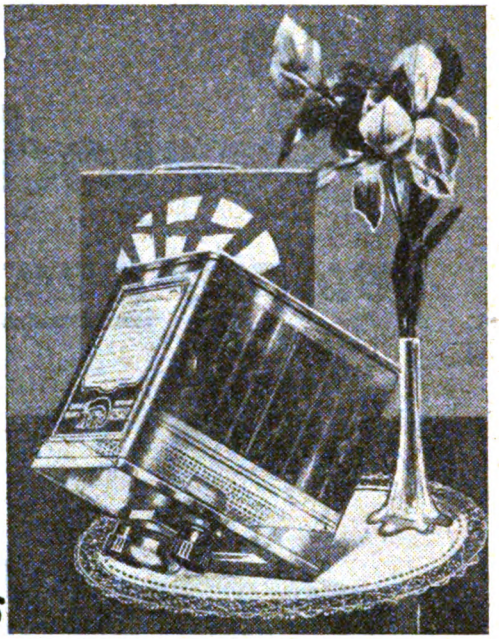

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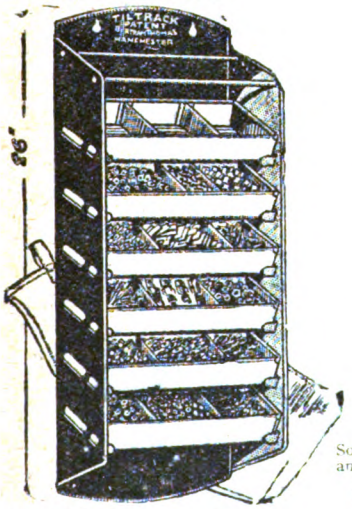

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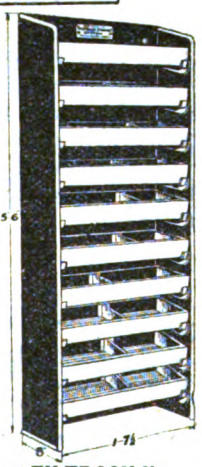

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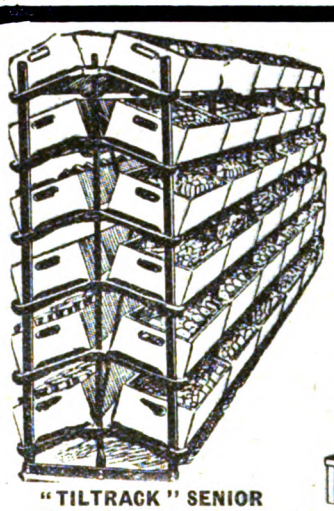

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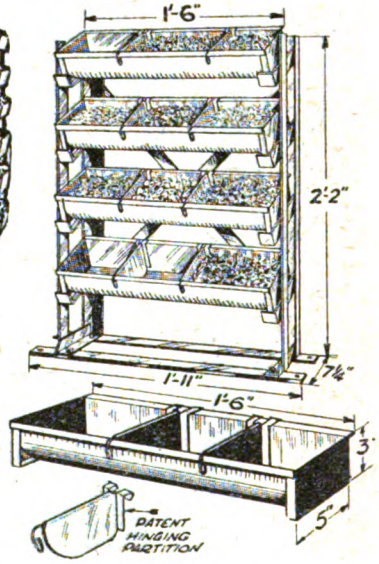

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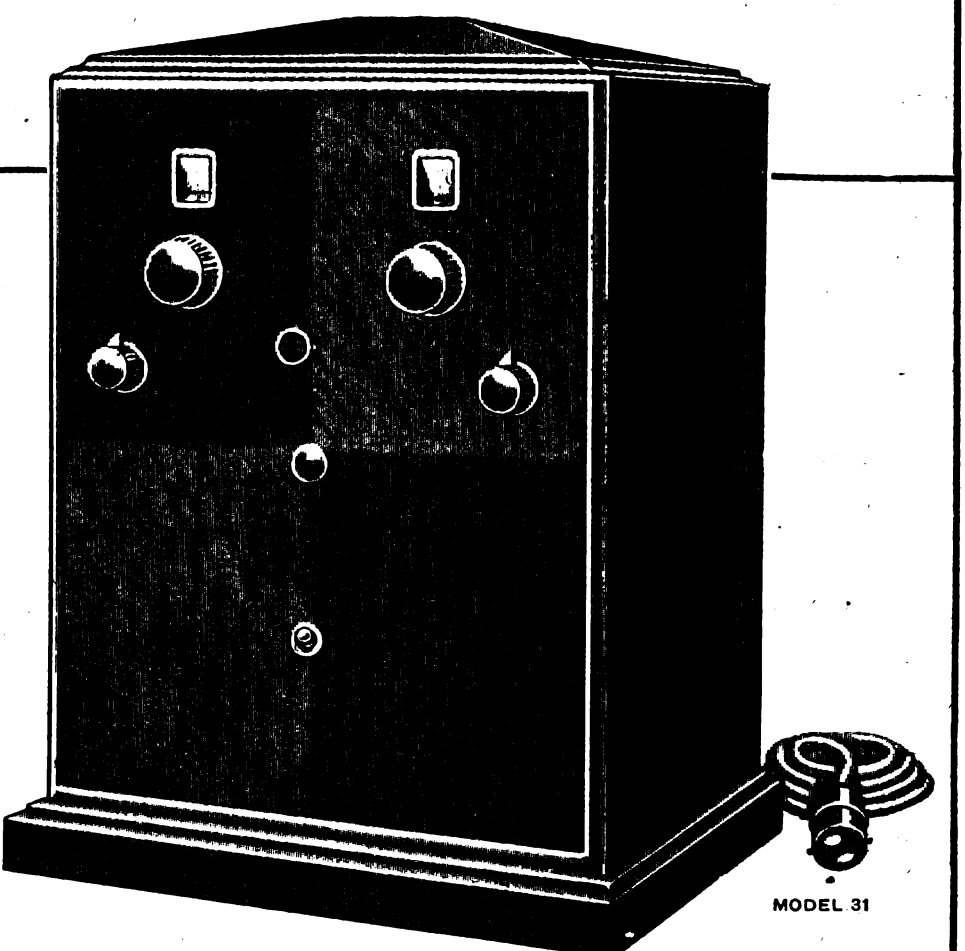

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MARCONIPHONE 5-valve Portable Receiver, type 53, absolutely brand new, unused, accumulator not yet charged; £19, cost 28 guineas.—21, Arundel Rd., Tunbridge Wells. [7698

MARCONIPHONE 82 Superhet, 8-valve, complete, 105 cone speaker, new 120v Exide H.T., new 6v. 100 amp. L.T.; cost £70, offers.—White Bros, Epsom 434. [7725

GREAT Opportunity.—Having many requests for famous Royal Air Force 3-valve receivers, we have now procured limited number; these receivers give excellent loud-speaker reception, each set specially tested before delivery to ensure satisfaction, all are guaranteed brand new and perfect; the original cost of these sets was £18; special travelling case with each set; we are sacrificing at the absurdly low price of 32/6.

GUARANTEED and Absolutely New McMichael Supersonic Kits, including mahogany cabinet, book instructions, blue prints; clearance price only £3; these sets can get the whole world; without cabinet, price £2.

J. B. HUMPHREYS and Co., 23, College Hill, Cannon St., London, E.C.4. [7718

ACCUMULATOR HIRE.

DON'T Buy Accumulators or Dry Batteries, join our C.A.V. low- and high-tension accumulator hire service, the largest and best in London; better and cheaper reception with no trouble; regular deliveries within 12 miles of Charing Cross; no deposit, payment on delivery or by subscription; over 10,000 satisfied users; explanatory folder post free; 'phone or write to-day.—Radio Service (London), Ltd., 105, Torriano Av., N.W.5. 'Phone: North 0623-4-5. [7596

C.D.E.S. Accumulator Hire and Maintenance Service (5 mile radius).—98, Cherry Orchard Rd., Croydon. [6374

BATTERIES.

WET H.T. Replacements.—Sacs (capped or uncapped), highest grade, No. 1, 10d. per doz.; No. 2, 1/9 per doz.—See below.

ZINCS.—Best quality (wired). No. 1, 8d. per doz.; No. 2, 9d. per doz.; orders valued 5/- carriage paid, otherwise 6d. for postage.—British Battery Co., Clarendon Rd., Watford, Herts. [0258

PENTODE Users.—Write for details of new size self-charging wet battery; 20,000 milliamps, 6d. per volt; illustrated catalogue giving data, post free.—U. Taylor, 57, Studley Rd., Stockwell, London. [0273

WET H.T. Batteries.—Parts per dozen, jars, No. 1, 2½×1½ square, 1/3; No. 2, 1/6; zincs, No. 1, 10d.; No. 2, 11d.; sacs, No. 1, 1/2 dozen; No. 2, 1/9; terminals, 8d., 10d.; dozen cells (18 volts), complete with bands and electrolyte, No. 1, 4/1; No. 2, 5/-; post 9d.; high efficiency, long life, self charging, upkeep small; send 6d. for sample unit; illustrated booklet free, carriage free orders 10/-; write for free list wireless bargains, trade supplied.—W. Taylor, 57, Studley Rd., Stockwell, London [0039

PETO and RADFORD'S 50-amp. 6-volt Accumulator, in perfect order; £1.—Colonel Kennard, 2, Adelphi Terrace, W.C.2. [7695

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Make your new set a better set with the Brownie POPULAR Transformer. Although it costs only 9/6, its purity of amplification gives a more vivid clarity of reproduction throughout the musical scale, while its sturdy British build ensures that once it is fitted the words "transformer troubles" can be eliminated from your list of worries.

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These Cabinets are made by experts and are thoroughly electrically sealed.

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Every description of Wireless Cabinet supplied. Screening Boxes, Eliminator Cases, etc.

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VORTEXION Transformers, chokes, etc., wound to any specification; write or 'phone for quotation; best quality components only.—Vortexion, 72, Merton Rd., Wimbledon, S.W.19. Tel.: Wimbledon 2814. [0319

ATLAS Eliminators, D.C. £1/17/6, A.C. £3/17/6; Nesper trickle chargers, 29/6. 'Phone: Gerrard 6268 for demonstration.—Greatrex and Co., 184, Regent St., London. [6451

TANTALUM and Lionium for A.C. Rectifiers; make up your own inexpensive chargers; blue prints for H.T. and L.T., 1/- each; Lionium electrodes fitted with terminals, 2-3 amps. and 5-8 amps.—Blackwell's Metallurgical Works, Ltd., Speke Rd. Works, Garston, Liverpool. 'Phone: Garston 980 (2 lines). [6282

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ALL Models Obtained for 10/- Deposit; take advantage of this and get constant high tension immediately.

WRITE for Our Booklet, "Radio Power" to Philipson and Co., Ltd., Radio Engineers, Astley Bridge, Bolton. 'Phone: 2038. 'Grams: Safety, Bolton. Est. over 50 years. [0318

CHEBROS.—Chebros for all types of transformers and chokes, high grade instruments at a very moderate price; enquiries invited.—Chester Bros., 244, Dalston Lane, London, E.8. [5290

FEL-ECTRIC RADIO Eliminator Kit, transformer, choke, valve holder, valve, 3 condensers, variable resistance, insulated terminals, sleeving, wiring diagram; 37/- complete; output 15 m.a. at 120 volts; send for lists.—Fel-Ectric Radio, 56, Garden St., Sheffield. [7411

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240 A.C. Charger, cost £7, charges 2, 4, or 6 volt at 0-10 amp., also 15, 45 volt H.T. at 0.25 amp., a really good job, will guarantee; £3/10.—Spencer, 92, Umfreville Rd., Harringay, N.4. [7660

SAVAGE'S Specialise in Wireless Power from the Mains, reliable apparatus at reasonable prices.

SAVAGE'S Transformer Laminations and Bakelite Bobbins; intending home constructors should write for list.

SAVAGE'S Reliable Smoothing Condensers.—1,000 volts D.C. test, 2 mfd. 3/-. 4 mfd. 5/3; 500 volts D.C. test, 1 mfd. 1/6, 2 mfd. 2/3, 4 mfd. 3/9.

SAVAGE'S Super Smoothing and Output Chokes.—Many types available, write for list.

SAVAGE'S Mains Transformer for Westinghouse Rectifiers.—H.T.4, 18/6; A3, 17/-; A4, 20/-.

SAVAGE'S Mains Transformer for Westinghouse H.T.4 Unit, with additional winding, 4 volts 3 amps; 23/-.

SAVAGE'S Mains Transformer.—V.T.31, 200-0-200 volts 60 m.amps., 2+2 volts 2 amps., 2+2 volts 3 amps.; 28/-.

SAVAGE'S Mains Transformer.—B.T.3 500-0-500 volts 120 m.amps., 3.75+3.75 volts 3 amps., 3+3 volts 3 amps., 2+2 volts 3 amps.; 51/-.

SAVAGE'S Mains Transformers and Power Chokes are carefully and individually constructed from first class materials with an exceptionally generous margain of safety.

SAVAGE'S, 146, Bishopsgate, London, E.C.2. 'Phone: Bishopsgate 6998. [6808

HEYBEARD'S Overnight Charger, 2-4-6 volts, with spare valve, in perfect condition; £1.—Colonel Kennard, 2, Adelphi Terrace, W.C.2. [7694

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ARTCRAFT Radio Cabinets are Britain's Best Value. [0313

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KAY'S Cabinets, the greatest range of pedestal cabinets in the kingdom; original creative designs at prices 50% lower than elsewhere; quotations for specials by return; delivery at short notice guaranteed; moving coil, portable, baffle, vignette, radiogramo, electric pick-up, television, etc.; illustrated list free.—H. Kay, Wireless Cabinet Manufacturer, Mount Pleasant Rd., London, N.17. 'Phone: Walthamstow 1626. [6461

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For the sale or purchase of Portable or other Receivers use the Miscellaneous Columns of "The Wireless World." A recent advertiser writes as follows:

"I am very satisfied with the results obtained. The Portable set was sold the same day, and I had over twenty other replies, including prepaid Telegrams. I also had a large number of callers, and altogether am very pleased with the pulling powers of your valuable paper."

M. A. FROST,
54, Clerkenwell Road,
London, E.C.1.

W.W.85

Wonderful Response!

A recent advertiser in "The Wireless World" writes:—

"I should like to inform you of the wonderful response to my advertisement in 'The Wireless World.' I have received no less than 20 applications for the Ferranti and Marconi Transformers and most of the other goods have been sold."

W. H. Trevett,
80, High Street,
Erith, Kent.

W.W82.

Cabinets.—Contd.

ARTCRAFT Radio Cabinets are Britain's Best Value. [0311

HORNS for Cabinets, portables, etc.; illustrated list.—Maddison, 1, Chapel St., Edgware Rd. [6142

ARTCRAFT Radio Cabinets; Britain's best value; lowest prices consistent with highest quality; illustrated list free from actual manufacturers.—Artcraft Co., 156, Cherry Orchard Rd., Croydon. 'Phone: Croydon 1981. [0040

CABINETS, 16½in.×7½in.×11in., hand mahogany finished 7/6, unpolished 5/6; oval front, 10⅞in. ×6¼in., 6d. extra; portable cabinets, 16½in.×16½in. ×8in., £1/5; baseboard, 6d.; carriage free.—F. W. Ramsey, 63, Shaftesbury St., London, N.1. Clerkenwell 7139. [7584

CABINETS.—A fine gift, something new: Combined loud-speaker cabinet, bookshelf, newspaper rack and occasional table, 30in. high, take any unit up to 18in.×17in., handsome cabinet, well made, superior finish; solid oak 35/-, solid mahogany 40/-.—Below.

ANOTHER New Line.—Handsome fire screen loud-speaker 31in. high, brown enamelled frame, 3-fold, covered with best quality sateen, strongly wired, complete with baffle and shelf, take any unit up to 14in.×14in; price 15/-.—Below.

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FINEST American Types, astonishing value, special offer oak cabinets, hinged lid, baseboard, highly polished, take 12in.×6in. panel; sample, carriage paid, 6/6; trade discounts for quantities.—Mag-Radio, 112, Warstone Lane, Birmingham. [2665

ARTCRAFT Radio Cabinets are Britain's Best Value. [0310

LOUD-SPEAKER Cabinets, extraordinary offer, oak cabinets, handsome fret front, highly polished, 13in. square, 6in. deep, finished moulding, take all ordinary units; sample, carriage paid, 6/6; trade discounts for quantities.—Mag-Radio, 112, Warstone Lane, Birmingham. [2666

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600-OHM Decoupling Resistances for New Kilo-mag Four, foreign listeners' four, and all "Wireless World" circuits, hand made and tested in our own workshops; improved model wound with Constanton wire, 1/6 each, post free.—Groves Bros., St. Mary's Place, Shrewsbury. [7361

1,000-OHM Decoupling Resistances for "Wireless World" Circuits; 1/6 each, post free.—Groves Bros. St. Mary's Place, Shrewsbury. [7362

RADIOGRAPH.—W.W. coils, Record III, 35/-; new Kilo-mag Four, 33/-; S.G. Regional, 37/6; foreign listeners' Four, 37/6 set; Europa Portable, 21/-; Europa III, 18/6; S.G. multi-valve portable, 22/6; new Everyman Four, 42/6.

RADIOGRAPH.—Litz wire, 9/40, 1/6; 27/42, 2/6 dozen yards; Redfern's deep ribbed or Becol tube, 5d. per inch, slotting 1/6 extra.

RADIOGRAPH, Ltd.—W.W. cabinets, 4 compartments, 44/6; 2 compartments, 38/6; crackle enamel and oak finish.—Station Rd., Handsworth, Birmingham. [7441

A.F.5, 15/-; Ideal 6 to 1, 9/-; Igranic old type 5-1, 2/6; Croix 5-1, 2/-; Cosmos H.F. choke, 2/6; Lissen L.F. choke, 2/-.—Liversedge, 5, Eastfield Rd., Benton, Northumberland. [7680

FERRANTI A.F.5C., O.P.3C., 2 100,000 ohms resistances, never been used; 45/-.—Bailey, 47, Stowe Rd., Shepherd's Bush, W.12. [7656

SIMMONDS BROS.—Berclif coils, Record Three, 50/- pair; new kilo-mag. four, 50/- set; foreign listeners four, low, 30/-; long wave, 37/-; screened grid Regional, 40/-; Mullard S.G.P. dual range coils, 30/- pair; Berclif standard coils, for new all-wave four, standard four, A.C. three, Everyman four, etc., 63/6 set of 4, with bases; the same coils for the Lodestone series ("Wireless Magazine"), 65/9 set of 4, with bases; Titan unit, 15/-; decoupling resistances, 600 ohm, 1/6; 1,000 ohm, 2/-; all "Wireless World" and similar coils in regular production by the leading specialists; lists free; trade supplied.—Simmonds Bros., Shireland Rd., Smethwick. Tel.: Smethwick 751. [6314

STANDARD Four Type Coils, set of 4, with bases, 30/-; Netrovernier, 3/-.—Bowden, 28, Knighton Rd., Plymouth. [7714

MARCONIPHONE Ideal Junior Transformers, formerly 18/-, clearing at 12/6; Marconiphone Popular transformers, formerly 12/6, clearing at 9/6; both post free; guaranteed new, in makers' original boxes.—Hall.

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EXPONENTIAL Horns for Cabinet Gramophones and Wireless, metal and wood; list.—Maddison, 1 Chapel St., Marylebone, N.W.1. [6141

B.T.H. Pick-up and tone arm, almost unused; 28/6.—Box 4233, c/o *The Wireless World*. [7653

NEW Philips Pick-up for Sale; 32/6, cost 50/-.—Ellis, 28, Redhill Drive, Edgware. [7658

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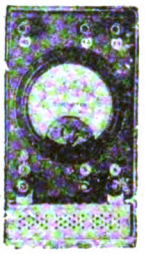

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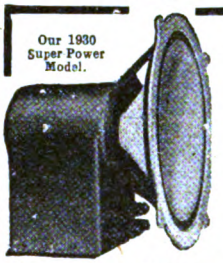

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EPOCH.—Moving coil speakers.

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EPOCH.—A Merry Xmas.

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EPOCH Wishes the Readers of "Wireless World" a Merry Xmas.

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EPOCH.—We rejoice in the knowledge that at this Xmas thousands of users of Epoch moving coil speakers will sit at their festive firesides with their friends thanking their happy choice, and us, for the marvellous, flawless reproduction they will be listening to, from their speakers.

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EPOCH.—At this time a word of apology, and an explanation, would not be amiss.

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EPOCH.—We must apologise to the vast number of people who were compelled to buy inferior instruments because we could not give them quick enough delivery; many of them have since bought Epochs.

EPOCH.

EPOCH.

EPOCH.—We must express our sympathy to hundreds who went to dealers and were persuaded to buy makes of inferior quality but larger profits.

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EPOCH.—We must express our sympathy to those who believed the dealers or factors that no definite date of delivery could be promised on Epochs, whereas, thanks to our constantly increasing facilities, deliveries have been much better than many other wireless lines for which the demand is big.

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EPOCH.—We must apologise, however, to those who have suffered by mistakes and delays due to departmental errors, unavoidable in a growing organisation with constantly added new staff.

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EPOCH.—Our policy has been, and is, to give our customers our best, whether in regards to the quality of our products, which we endeavour to maintain at the highest, regardless of price, or as to prices, which are the lowest consistent with that aim; our service, despite the small margin of profits possible on our prices, is, every user can testify, generous in the extreme.

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EPOCH.—We must express our deep gratitude to the many hundreds of users who have written us, and to the thousands of others who have brought to our notice their expressions of satisfaction.

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EPOCH.—We must also express our deep appreciation of all our users who are spreading the fame of our speakers to their friends; they are our real salesmen, for we employ no others.

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EPOCH.—To those who are not users we say: Join the fast increasing Epoch family and be happy all the New Year and next Xmas as well.

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EPOCH RADIO MANUFACTURING Co., Ltd., are the manufacturers. City Office and Service Station, 3, Farringdon Av. (Ludgate Circus end), E.C.4. 'Phone: Central 1971 (2 lines). Private Branch Exchange. [7717

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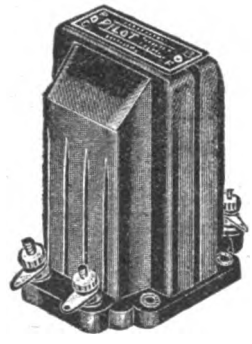

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W.W.88.

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"Bræmar,"
Ballymena, Ulster.

W.W.89.

Loud-speakers.—Contd.

HORNS of All Descriptions for Loud Speakers and Gramophone Units.—H. Maddison, manufacturer of the Allwoodorn, 1, Chapel St., Paddington, N.W.1. [6143

AMPLION Mahogany Speaker; £6, sell £2; splendid instrument.—BM/FZS, London, W.C.1. [7684

MAGNAVOX M Type Speaker, 25/-; Baker H.R. moving coil speaker, 110 volts, 25/-; 50 and 100 milliamps Jewel meters, 10/- each.—Col. Bayldon, Beaulieu, Hants. [7685

B.T.H. Rice Kellogg, 6 volt, perfect; 50/-, near offer. —70, Deyncourt Gardens, Upminster, Essex. [7671

SELF-CENTRE Ball and Socket Device, when fitted to your cone unit, will relieve driving rod of all undue side stress, centering the cone in relation to driving rod improving results all round; provisional patent applied for; price 2/6; c.o.d. terms available. —Weedon, 80, Lonsdale Av., London, E.6. [7487

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GREAT Bargains.

GREAT Bargains.—Epoch model A moving coil speaker kit (or complete units), brand new; a large number of these famous instruments made for a special order for use in talkies, but not executed, for credit reasons only; regular prices, £3/10, £4/2, and £5/17/6, to clear at 50/- for accumulator operation, 55/- for D.C. mains operation, 85/- for A.C. mains; kits comprising copper plated super magnet-pot (weight 23 lb.) Chrystalene frame, fully adjustable, moving coil, any impedance, paper, leather and mounting rings, made up complete, if desired, 6/- extra.

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GREAT Bargains.—In fact, the greatest bargains ever offered! A number of Epoch model A used kits at given away prices, guaranteed in perfect working order; early 1928 model, 35/-; latest model, 42/6; made up complete, if desired, 6/- extra.

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6-VOLT ½-amp. M.C. Speaker; list £6 new this year; 29/6; 7 days approval against cash.—Brew, Pytchley, Kettering. [7708

MARCONIPHONE Popular Horn Loud-speakers, adjustable unit, dark mahogany crystalline finish, absolutely new, in makers' original sealed boxes; formerly 42/-, clearance price 15/- each, postage 1/-.—F. J. A. Hall, 91, Fore St., Edmonton, N.18. [7720

MARCONIPHONE Type 105 Cone Speaker, brand new, not yet unpacked; £2/17/6, cost £5/5.—Below.

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CELESTION C24, mahogany, unused; cost £21, accept £12.—"Kalua," Chorley Wood Rd., Rickmansworth. [7690

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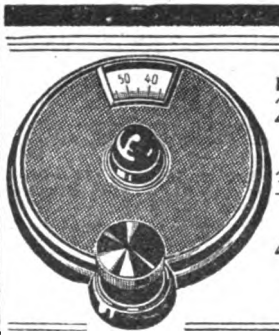

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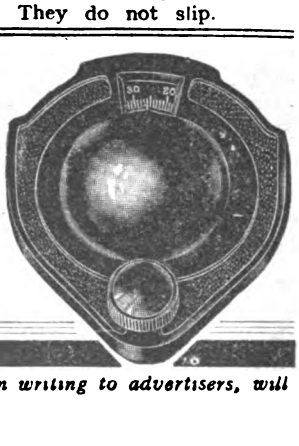

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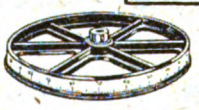

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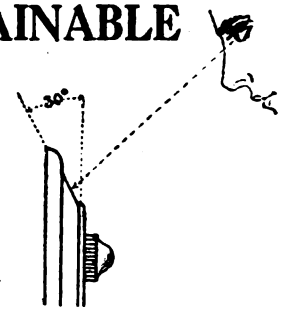

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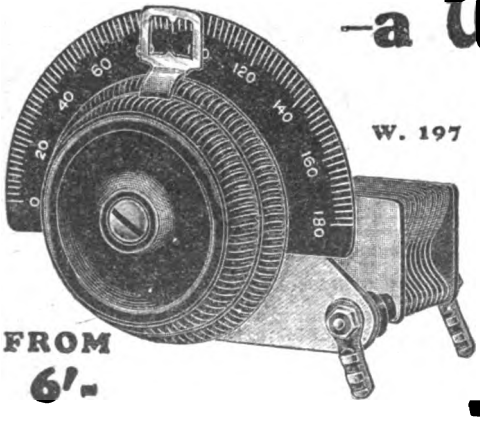

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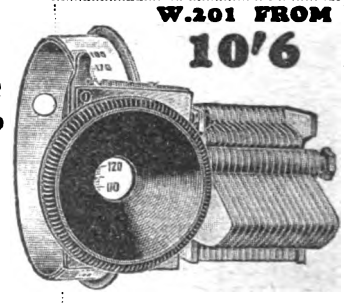

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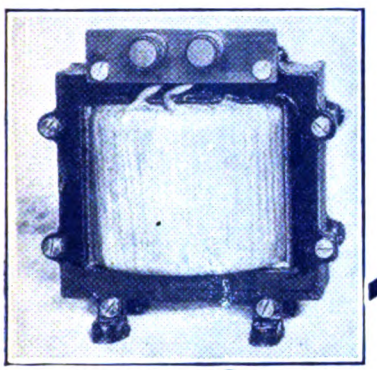

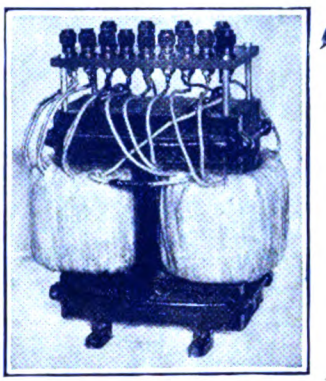

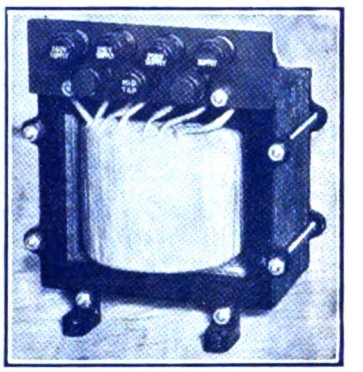

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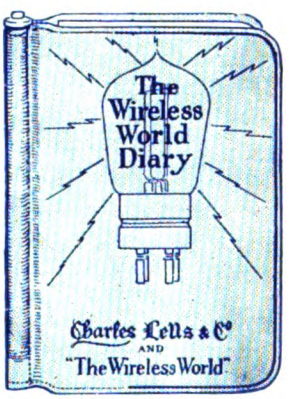

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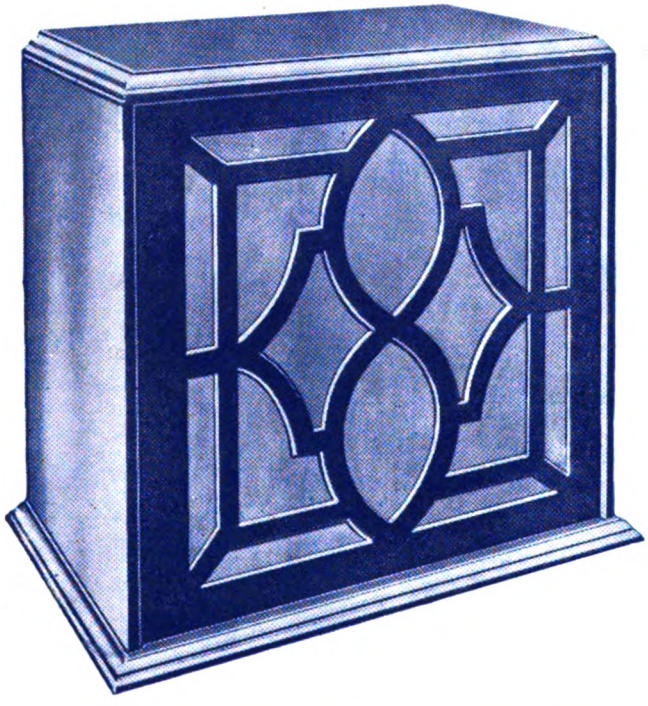

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